MEDICAL INFORMATION SEARCHES IN A PATIENT PORTAL USING MEDLINEPLUS CONNECT: AN ANALYSIS OF USAGE BY PREDOMINANTLY UNDERSERVED PATIENTS IN A NY STATE NETWORK OF FQHCS

A Thesis

Presented to the Faculty of the Weill Cornell Graduate School

of Medical Sciences

in Partial Fulfillment of the Requirements for the Degree of

Masters in Health Informatics

by

Christopher A. Way

August 2015

ABSTRACT

BACKGROUND: Patient Portals are secure websites that give patients access to their own medical records. One function, MedlinePlus Connect (MPC), lets patients use National Library of Medicine resources to look up unfamiliar medical and health-related vocabulary in their records. Increased access to this tool could improve access to timely, authoritative information, which in turn could increase patient-led management of their own illnesses, as well as psychological benefits in the form of an increased sense of control and confidence.

OBJECTIVE: In a study population of safety-net patients, we seek to determine (a) associations between MPC use and various demographic and clinic usage characteristics and (b) predictors of MPC usage, with the purpose of understanding MPC user-ship in general and the nature of any disparities that may exist in usage of this tool.

PATIENT POPULATION: We collaborated with the Institute for Family Health, a federally qualified health center network in New York. The study cohort is all IFH patients who had at least one in-person provider encounter between February 2011 (when MPC was implemented) and September 2014 (n=133,667). Of these, 31,718 (24%) logged in to their patient portal at least once. Among the portal users, 13,491 (43%) used MPC at least once.

METHODS: This is a retrospective cohort study. Chi-Squared tests will be used to examine associations between MPC usage and various outcomes and patient characteristics. Correlation tests will examine relationships between MPC usage and other core variables. Regression models will be used to explore the predictors of MPC usage.

RESULTS: Medicaid, dual-eligibles and self-pay constituted in aggregate 55.8% of all MPC users' insurance vs. 55.1% of all non-MPC users' insurance ($P = 0.0004$). Black MPC users constituted 22.4% of all MPC users vs. 21.7% of all non-MPC users ($P=0.0007$); among those of Hispanic ethnicity, 27.7% were MPC users vs. 26.2% which were non-MPC users ($P=0.0094$). Multiple logistic regression showed that poverty made a patient 6.7% more likely to use MPC ($P=0.0072$), while being male makes a patient 13.1% less likely of MPC use ($P<0.0001$).

IMPLICATIONS: As expected, MPC users skew more female, white, & young compared to all patients. However, contrary to our hypotheses, under-served populations (as a function of encounter coverage type, race, preferred language and ethnicity) are not under-represented when it comes to MPC usage, and in some cases show incremental gains in total percentage when compared with non-MPC users. Logistic regression corroborates this finding, determining "poverty" (a constructed variable aggregating Medicaid, self-pay and uninsured insurance types) to be a statistically significant predictor of MPC usage.

BIOGRAPHICAL SKETCH

Chris was born and raised in Florida, and received his Bachelor of Arts degree in English (with a minor in Religion) from the University of Florida in 1999, graduating magna cum laude.

ACKNOWLEDGEMENTS

Thank you to Dr. Jessica Ancker, I.F.H., Dr. Joshua Richardson, Daina Bouquin, Leonid Shovsky and the Data Core team, Lyubov L. Tymanova, Dr. Stephen Johnson, Guojiao "Sophie" Wu

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION & BACKGROUND

Chronic disease remains a significant, costly & ever-growing U.S. healthcare problem, especially for the underserved, who continue to experience poorer quality care, reduced access to care, worse chronic disease outcomes, higher prevalence of diabetes and obesity, and greater rates of MCC (Multiple Chronic Conditions) compared to the rest of the population.(1)(2)(3)(4)(5)(6)(7)(8)(9)(10)

Patient-centeredness, one of the six domains of health care quality as defined by the Institute of Medicine (IOM) (11), and one of the main focuses of the national effort to address MCC (12)(13)(14), has increasingly been shown in the last two decades to be tied to improved chronic illness outcomes (15)(16)(17)(18). Some studies suggest that Health information technology (HIT) may help patients manage chronic disease, especially to the extent that HIT interventions may improve patient-centeredness, patient-activation and patient-engagement. For example, for patients suffering from chronic disease, HIT has been shown to improve core attributes of patient-centeredness (11)(19)(20): patient-provider communication (21)(22), patient engagement through self-management and medication adherence (21)(23)(24)(25)(26), integration and coordination of care (21)(27)(28)(29), and access to educational resources related to patients' chronic conditions (21)(22)(23).

One HIT intervention in particular, patient portals -- secure websites that provide patients access to their medical records, lab results, secure messaging to reach providers, scheduling options, and educational resources (among many other functions) -- seems to hold the most promise for improving patient-centeredness,

given that by their nature portals create multiple opportunities for patients (with providers' help) to access and engage with their providers and relevant medical information (30)(31)(32)(33)(34)(35). There has also been much energy devoted to measuring possible correlations between portal use and improved health outcomes and process measures.

1a. Patient Portal Literature: Outcomes

Patient portal usage, either in aggregate or, less often, via a particular function (most often secure messaging (36)(37)) has rarely been shown to be meaningfully associated with an improvement in clinical outcomes(38)(39). When it has, the impact has typically been minimal to bio-measure changes such as A1C test results or LDL cholesterol levels. Studies demonstrating incremental health outcome gains often acknowledge multiple confounders, chief of which is an uncertainty as to whether reported outcome changes were attributable to portal use or to other pre-study factors or external patient behaviors (40)(41)(42)(43). On the other hand, increased patient satisfaction (often through self-report), a softer but still meaningful measure of healthcare quality, is a fairly common associated outcome in portal literature (37)(41)(42)(44).

But while the literature shows a tenuous association between portal use and health outcomes, it often demonstrates a stronger connection between portal use and various health process measures and use of medical resources such as clinic visits, medication adherence and patient-provider communication (38)(45)(46). This connection can be

variable depending on perspective. For instance, while some researchers have found use of a patient portal to be associated with an increase in communication (through phone, electronic or paper means) and/or clinic visits (30)(41)(42)(47), others have not (39)(45)(48)(49)(50). In addition, different studies see the direction of change as positive or negative depending on framing of the outcome (for instance, in some cases, fewer in-person clinic visits means fewer drains on resources and fewer potentially-unnecessary associated costs; in other cases, this decrease in usage could signal diminished patient engagement and lost opportunities for the healthcare system to serve the patient).

Treatment and medication adherence, medication error identification, and vaccination frequency are other important process measures which have been shown to be favorably tied to patient portal use (45)(51)(52)(53)(54). Studies also found intermediate positive outcomes relating to how portal use increases patients' ability to discover and report mistakes in their medical records related to their own medication (55)(56). While causal or associative links between health outcomes and portal use are infrequent and confounded in the portal literature, process measures (important proxies to health outcomes) are often more convincingly correlated (57)(58).

How has the patient portal been shown to help, if at all, with chronic disease management? In general, some studies have demonstrated how HIT and eHealth can play a key role in helping manage chronic illness, one backed by major U.S. health initiatives (IOM, AHRQ) (59). The portal literature addressing this question is substantial, with an abundance of studies focusing on populations suffering from diabetes, hypertension, heart disease or other core chronic conditions

(22)(28)(36)(40)(42)(44)(52)(55)(60)(61)(62)(63). Some studies report that, if outcomes associated with portal use are to be found at all, such outcomes are chronic condition-dependent (64); the consensus, however, is mixed as to what extent – and precisely how – these interventions impact populations suffering from chronic illness. Only a select few cases describe portal use associated with small improvements in quality measures and health outcomes (42)(60), while most do not (61)(65); those that report improvement do so based on improved process measures such as patient satisfaction, or patient-led medicine reconciliation, to list two common examples. (42)(44)(52)(55)(63)

Overall, the literature related to patient portal use does not significantly correlate use to clinical outcomes, and is more strongly correlated with intermediate proxy measures. Many studies attribute the lack of establishment between portal use and clinical outcomes to the lack of a framework or model for understanding how specific types of usage within patient portals across diverse users and settings are actually supposed to improve health. (29)(38)(66)

1b. Patient Portal Literature: Generalizability and Bias

The generalizability of patient portal literature is limited for many reasons. For example, sociotechnical complexities inherent in a patient portal intervention are important to add context to studies' findings (29), and their absence in the literature makes it difficult to extrapolate from study results to a wider population. The patient

portal literature tends to be broad in its scope, exploring any usage of a portal and its associations with changes in patient outcomes or process measures.

But as others have argued (41)(67)(68), a complex cluster of contextual factors surrounding the HIT intervention itself can influence to what degree it has a measurable impact upon healthcare outcomes or process measures, among them: clinical workflow, the organization's technical resources, the nature of the tasks at hand, patient literacies (health, computer, etc.), workplace culture regarding technological interventions, and in the case of the patient portal, specific functions within such a complex multi-task intervention (not simply overall portal use). Further, as researchers have demonstrated, there is a great deal of heterogeneity across the portal studies regarding clinical setting, patient population and explored functions of the portal (41)(45)(69), compounding this complexity.

For example, a study population's health literacy, health numeracy or computer literacy are rarely assessed, but these characteristics been shown to support effective self-management (14)(28)(32); studies able to qualitatively or quantitatively report on a population's baseline literacies are able to generalize with greater specificity. In addition, some portal studies cite case managers and/or clinicians who become involved with enrollees, helping them adopt and practice HIT usage. The absence or presence of this information is vital in determining to what extent a patient portal study is generalizable (43).

Another reason for limited generalizability in portal literature is that studied settings are often major integrated delivery systems or academic medical centers. These settings feature demographic characteristics and chronic disease management

protocols that are sometimes quite different from those existing in the rest of the country (28)(52)(60)(70). This inhibits generalizability to the population at large, especially the uninsured and those cared for in non-integrated systems (such as found in rural settings).

Self-selection and other forms of sampling bias exist in the portal literature. Much of the sample selection is performed without randomization, and as Kruse, et al have shown in a 2014 systematic review of portal outcomes, "[studies] without randomization of participants run the risk of selection bias, which, in turn, affects the internal validity". (38)

In addition, the portal literature's sample populations feature volunteer portal users who share common characteristics: they are engaged with their health, computer-literature, female, younger, socioeconomically advantaged, and white. What's more, sometimes non-portal populations go unstudied, which impairs researchers' abilities to determine lift in health effects attributable to portal use alone (52)(66). Except in cases where adequate controls exist to account for this bias, many of the studies find their generalizability impacted accordingly (44)(49)(63)(65)(72)(73). In and of itself this isn't necessary problematic (studies don't need to generalize to the widest possible N), but can be an issue depending on the stated goal of the study.

1c. Patient Portal Literature and the Underserved

For the all the reasons above, there is a relative paucity (but, happily, a diminishing one (72)(74)(75)(76)) of studies examining how patient portals function in

underserved populations. This underscores prevailing socioeconomic disparities among the underserved (defined here, following HRSA's Index of Medical Underservice(77), and other definitions(78)(79)(80), as populations living in communities which experience some function of the following variables: (a) ratio of primary medical care physicians per 1,000 population, (b) infant mortality rate, (c) percentage of the population living under the poverty level, (d) percentage of individuals aged 65 or older), manifesting as gaps in health literacy, health numeracy, and especially computer literacy (70)(81)(82)(83)(84).

With respect to patient portals, these gaps mean that the underserved are not only unlikely to use these tools regularly or without difficulty (75)(85) – they may not even be notified of their existence in the first place (72). In addition, they may even feel their language barrier to be an impediment to using this kind of HIT (83). The most vulnerable among us, with the lowest health and computer literacies, are those most likely to use health care services, and are those most likely to benefit from this technology (74).

Still, there is great opportunity here for the underserved regarding HIT use and access, especially in the rapidly expanding realm of mobile health. In particular, the high prevalence of smartphone possession and use among the underserved (86)(87) (even in the absence of housing, employment and home/desktop internet capacity (87)(88)), these devices' affordability (86)(89), and their capacities to access a range of tools and patient portal functions (in addition to other HIT functions, such as telemedicine) (86)(87)(90) suggest ways in which the digital divide could begin to be bridged.

Given the results of the literature to date, the real value of patient portal effects & outcomes research may be best demonstrated not by examinations of overall use or non-use, (with a technology so varied in its functionality, extrapolations drawn from aggregate use are sometimes limited in value (66)), or to what extent they are associated with changes in process measures or bio-measures (45)(46).

Rather, effects of a patient portal may be more readily explored via *specific* portal functions (41)(60)(66) studied in a sociotechnically described clinical context and with a specific patient population in mind as a generalizability target (41). This approach may limit widest possible generalizability, but as demonstrated above, much of the portal literature, in its attempt to generalize broadly, has missed opportunities to deliver focused findings on specific populations & settings.

1d. A Specific Patient Portal Function: MedlinePlus Connect

Our objective in this study was to analyze EHR data and other data associated with use of a bi-lingual medical information search tool embedded in a patient portal, MedlinePlus Connect (MPC), in underserved populations with high prevalence of chronic disease.

In line with HIT literature exploring prevailing socio-economic disparities, and on the basis of previous analyses of similar data-sets from the same network of FQHCs (72)(91)(92)(93), we hypothesize that being in a traditionally disadvantaged group (by race, ethnicity, or insurance status) would be associated with lower likelihood of using MPC.

Our secondary hypotheses: women will constitute a greater proportion of users than men, younger users will adopt the technology more than older users, and MPC users will be more likely to have multiple diagnoses and visit clinics more. We expect results of this study to be generalizable to safety-net populations nationwide with a high prevalence of chronic disease, and where patient portal adoption is occurring with at least some level of provider encouragement.

2. METHODS

2a. Setting

The Institute for Family Health (IFH) is a New York state based network of federally qualified health centers (FQHCs) offering primary care, mental health, dental care, social work, and other services to over 94,000 patients at 19 health centers located in Manhattan, the Bronx and the Mid-Hudson Valley.(91)(93)(94) IFH health centers are staffed by more than 100 physicians, most of them family practitioners. IFH is currently a level III Patient-Centered Medical Home with approximately 54% of practitioners having achieved Meaningful Use stage one or two as of 2014.

IFH was an early adopter of EHRs, having used the Epic EHR (EpicCare, Epic Systems, Inc, Verona, WI, USA) since 2001, and having first deployed its EHR patient portal, MyChart (licensed from Epic), in 2008. (95)

In October 2009, IFH worked with the U.S. National Library of Medicine (NLM), the Health Resources and Services Administration (HRSA), and Epic "to create direct links between patients' personal electronic health records and MedlinePlus.gov, NLM's database of authoritative consumer health information." (95)(96) The results of this collaboration helped form MedlinePlus Connect (MPC) a free service of the National Library of Medicine (NLM), National Institutes of Health (NIH), and the Department of Health and Human Services (HHS).

MPC, first available to IFH patients in 2011, allows health organizations such as IFH to link patient portals and electronic health record (EHR) systems to

MedlinePlus.gov to obtain up-to-date health information for patients, families, and health care providers, in English or Spanish, and delivered in language suitable for a lay audience.(95)(96) Clinician problem list diagnoses, lab tests and medications, as well as other pertinent health and wellness indicators are converted to hyperlinks in lay language created by Intelligent Medical Objects (IMO, Northbrook, IL, USA), in close partnership with Epic. It should be noted that these patient friendly terms changed somewhat over the duration of the study period to improve readability, and reduce confusion.

Clicking an MPC hyperlink takes the patient to that health object's corresponding MedlinePlus Connect intermediary page, where he or she can select from one or more applicable search results. Upon clicking a result, the patient is directed to the appropriate MedlinePlus entry where he or she can learn about what was clicked. This is shown in the example below, from the U.S. National Library of Medicine's MedlinePlus Connect overview page (96), showing the basic steps of MPC usage:

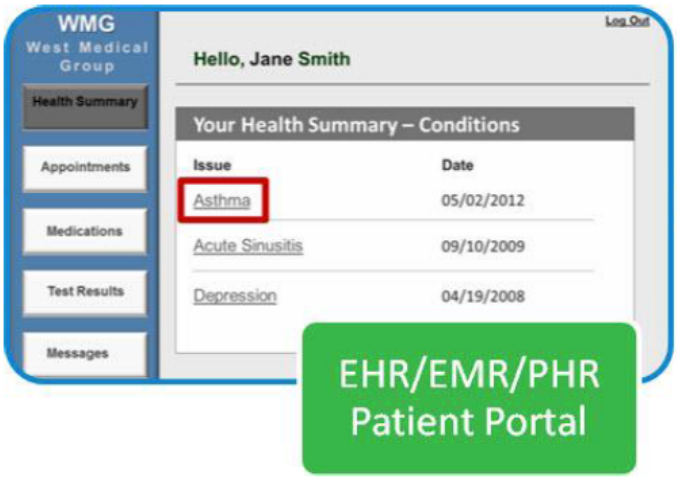

Figure 1 - Patient selects and clicks hyperlinked health-related item from within their portal, in this case a problem list diagnosis

Figure 2 - The MPC tool is activated; patient is shown a list of results pertaining to his or her clicked health item

Figure 3 - Upon clicking one of the results offered by MPC, patient is taken to a comprehensive entry on MedlinePlus.gov

IFH MyChart and MPC Timeline [a,b]	
2001 -	Epic launched (Epic Clinical, 2002)
4/2008 -	Epic's MyChart (patient portal) launched [c]
2010 -	Spanish version of MyChart launched
2010 -	Family Health Center of Harlem incorporated by IFH
2/2011 -	IFH launches MPC
8/2012 -	Soundview Clinic incorporated by IFH [d]
6/30/2013 -	MPC URL issue fixed [e]

Figure 4 - Major IFH events related to MyChart, MedlinePlus Connect, and overall patient population between 2001 and 2013.

Notes: a) At multiple times, from 2008 to 2014, as a part of multiple pushes to achieve quotas related to Meaningful Use, patients were offered MyChart by IFH clinicians, often in-office. b) MyChart account expires if client doesn't login for a year. c) NYC patients enrolled immediately, Hudson Valley 6 months later d) No definitive date of take-over was available at time of writing. e) Prior to this date, tracking URLs for MPC usage were truncated in error, preventing full data capture of language parameters, which in turn prevented insight into English vs. Spanish usage analysis prior to this date

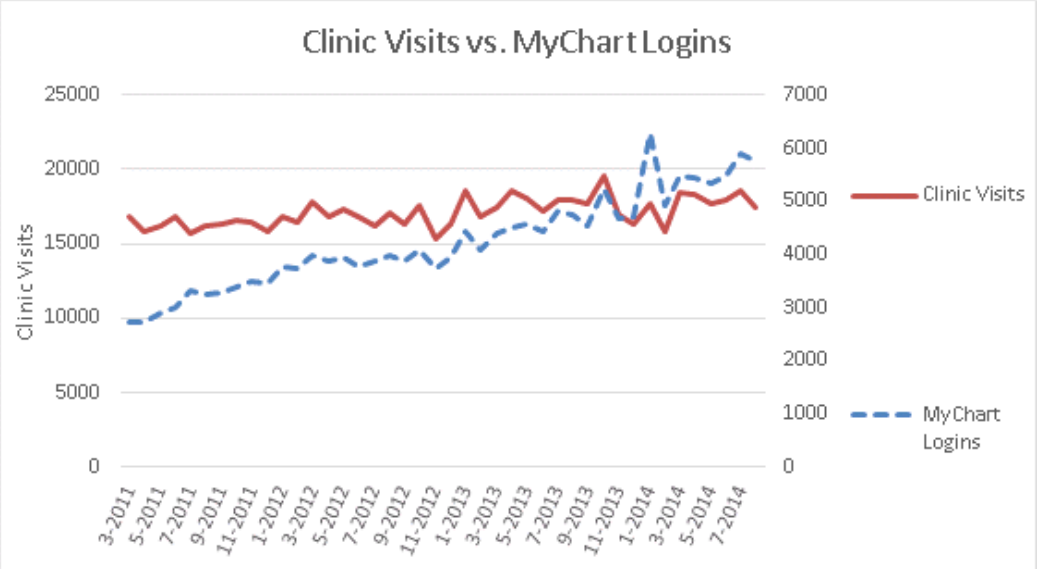

Figure 5 - Unique Patients with at Least One IFH Clinic Visit per Month (red) vs. Unique Patients Using MyChart per Month (blue, dotted, on secondary y-axis).

Notes: Due to IFH expansion and concerted IFH efforts to increase portal adoption, MyChart usage has experienced a faster rate of increase than clinic visits. (Note: chart draws from full months' data only -- 2-2011 and 9-2014 omitted since they are incomplete months)

2b. Study Design, Data and Sample

The study design is a retrospective cohort study, and the research population being generalized to is disadvantaged populations using a medical information search tool integrated in a patient portal. Our study sample was drawn from all IFH patients, a pool which consists predominantly of disadvantaged populations (approximately 61% are on Medicaid or are uninsured; approximately 53% were diagnosed with one or more chronic diseases (based on ICD9 problem list code)).

We analyzed patient data from all IFH patients from February 20th, 2011 through September 20th, 2014. IFH's EHR database provided the demographic characteristics (sex, age, race, ethnicity, preferred language), office encounters, primary care provider, and encounter insurance coverage type. IFH's portal database furnished data about access codes, activation of portal accounts, and logins. MedlinePlus Connect usage data was also obtained, providing clicked patient-friendly term and mapped problem list diagnosis codes.

Inclusion criteria for the study cohort: (1) age $\geq$18; (2) at least one in-person provider encounter between February 2011 through September 2014 (n=129,738).

2c. Measures

The primary dependent variables of interest were MPC usage and, secondarily, MyChart usage. MPC usage was defined as any clicked hyperlink in the MPC section

of a patient's portal. MyChart usage was defined as any patient login during the study period.

The primary independent variables were demographic (age, sex, race, preferred language, ethnicity), socio-economic (encounter coverage), and related to patient portal usage and clinic visits.

Additionally, the following variables were considered measured confounders and covariates: age, sex, portal usage level, frequency of clinic visits, ethnicity, race and insurance coverage. The following were considered unmeasured confounders: baseline co-morbidities, patient activation measure, strength of patient-provider relationship, health literacy, computer literacy, other types of portal usage occurring alongside MPC, educational attainment, income.

2d. Statistical Analysis

Chi-squared tests, Fishers exact tests and Spearman's rank correlation tests were used to analyze the demographic and process measure characteristics of patients who used the MyChart patient portal and MPC vs. those who did not.

After univariate analyses of all relevant covariates were performed, in order to screen for the most influential variables, multiple logistic regression was used to analyze predictors of MPC use. Analyses were performed using open-source statistical software R and Microsoft Excel (Microsoft Corp., Redmond,Washington).

2e. Approvals

The Weill Cornell IRB and The Institute for Family Health IRB approved this study. The IFH data sets were stripped of all identifiers specified by HIPAA with the single exception of dates upon which the electronic patient portal was accessed. This data set is therefore almost entirely de-identified, which led to the granting of a waiver of consent by both IRBs.

3. RESULTS

3a. Bivariate Results – Chi-Squared tests

Table 1: Characteristics of IFH patients who had at least one clinic visit from Feb 2011 to Sep 2014

Patient Characteristics	Used MPC at least once n=13,182 (42.9% of Portal Users)	Never used MPC n=17,511 (57.1% of Portal Users)	P	All Portal Users n = 30,693 (23.7% of All Users)	All Non-Portal Users n= 99,045 (76.3% of All Users)	P	All Users n = 129,738
Age							
Median Age (Mean, SD)	34.0 (37.5, 13.9)	33.0 (36.7, 14.1)		34 (37.1, 14.0)	39 (41.2, 16.35)		38 (40.2, 15.9)
18-27	3,911 (29.7%)	5,776 (33.0%)		9,687 (31.6%)	26,086 (26.3%)		35,773 (27.6%)
28-38	3,844 (29.2%)	5,008 (28.6%)	< 0.001	8,852 (28.8%)	22,229 (22.4%)	< 0.001	31,081 (24.0%)
39-52	3,275 (24.8%)	3,970 (22.7%)		7,245 (23.6%)	25,495 (25.7%)		32,740 (25.2%)
53+	2,152 (16.3%)	2,757 (15.7%)		4,909 (16.0%)	25,235 (25.5%)		30,144 (23.2%)
Sex, n (%)							
Female	9,233 (70.0%)	11,479 (65.6%)	< 0.001	20,712 (67.5%)	57,986 (58.5%)	< 0.001	78,698 (60.7%)
Male	3,949 (30.0%)	6,032 (34.4%)		9,981 (32.5%)	41,054 (41.4%)		51,035 (39.3%)
Race, n (%)							
Black	2,955 (22.4%)	3,796 (21.7%)		6,751 (22.0%)	23,023 (23.2%)		29,774 (22.9%)
Other Race & Many Race	3,731 (28.3%)	4,747 (27.1%)		8,478 (27.6%)	26,565 (26.8%)		35,043 (27.0%)
White	4,839 (36.7%)	6,829 (39.0%)	0.0007	11,668 (38.0%)	34,749 (35.1%)	< 0.001	46,417 (35.8%)
Unknown/Declined/Null	1,657 (12.6%)	2,139 (12.2%)		3,796 (12.4%)	14,708 (14.8%)		18,504 (14.3%)
Ethnicity, n (%)							
Hispanic or Latino	3,658 (27.7%)	4,586 (26.2%)		8,244 (26.9%)	26,838 (27.1%)		35,082 (27.0%)
Not Hispanic or Latino	8,278 (62.8%)	11,237 (64.2%)	0.0094	19,515 (63.6%)	59,626 (60.2%)	< 0.001	79,141 (61.0%)
Unknown/Declined/Null	1,246 (9.5%)	1,688 (9.6%)		2,934 (9.6%)	12,578 (12.7%)		15,512 (12.0%)
Preferred Language, n (%)							
English	12,510 (94.9%)	16,304 (93.1%)		28,814 (93.9%)	83,304 (84.1%)		112,118 (86.4%)
Spanish	389 (3.0%)	769 (4.4%)	< 0.001	1,158 (3.8%)	9,466 (9.6%)	< 0.001	10,624 (8.2%)
Other/Unknown/Declined/Null	283 (2.1%)	438 (2.5%)		721 (2.3%)	6,275 (6.3%)		6,996 (5.4%)
Insurance, n (%)							
Other/Null/Uknown	688 (5.2%)	1,099 (6.3%)		1,787 (5.8%)	4,705 (4.8%)		6,492 (5.0%)
Commercial	4,322 (32.8%)	5,750 (32.8%)		10,072 (32.8%)	20,129 (20.3%)		30,201 (23.3%)
Medicare	809 (6.1%)	1,016 (5.8%)	0.0004	1,825 (5.9%)	10,949 (11.1%)	< 0.001	12,774 (9.8%)
Medicaid	3,510 (26.6%)	4,418 (25.2%)		7,928 (25.8%)	30,229 (30.5%)		38,157 (29.4%)
Dual Eligibles	27 (0.2%)	33 (0.2%)		60 (0.2%)	505 (0.5%)		565 (0.4%)
Uninsured/Self-Pay	3,826 (29.0%)	5,195 (29.7%)		9,021 (29.4%)	32,528 (32.8%)		41,549 (32.0%)
In Office Encounters, n (%)							
Median (Mean)	7(13.0)	9(15.5)		7(13.0)	3(8.8)		4(9.8)
Light (1 to 2 visits)	1,794 (13.6%)	4,622 (26.4%)		6,416 (20.9%)	41,634 (42.0%)		48,050 (37.0%)
Moderate (3 to 10)	5,703 (43.3%)	7,724 (44.1%)	< 0.001	13,427 (43.7%)	35,704 (36.0%)	< 0.001	49,131 (37.9%)
Heavy (11+)	5,685 (43.1%)	5,165 (29.5%)		10,850 (35.4%)	21,707 (21.9%)		32,557 (25.1%)
Chronic Conditions							
Range (Mean)	0 to 24 (1.8)	0 to 24 (1.3)		0 to 24 (1.5)	0 to 27 (1.3)		0 to 27 (1.4)
0	4,378 (33.2%)	8,227 (47.0%)		12,605 (41.1%)	48,425 (48.9%)		61,030 (47.0%)
1	3,211 (24.4%)	3,844 (22.0%)		7,055 (23.0%)	18,897 (19.1%)		25,952 (20.0%)
2	2,099 (15.9%)	2,229 (12.7%)	< 0.001	4,328 (14.1%)	11,878 (12.0%)	< 0.001	16,206 (12.5%)
3 to 4	2,209 (16.8%)	2,093 (12.0%)		4,302 (14.0%)	12,653 (12.8%)		16,955 (13.1%)
5 to 17	1,285 (9.7%)	1,118 (6.4%)		2,403 (7.8%)	7,192 (7.3%)		9,595 (7.4%)
ADG Count							
Range (Mean)	0 to 9 (0.5)	0 to 6 (0.4)		0 to 9 (0.4)	0 to 10 (0.4)		0 to 10 (0.4)
0	8,770 (66.5%)	13,071 (74.6%)		21,841 (71.2%)	70,808 (71.5%)		92,649 (71.4%)
1	3,116 (23.6%)	3,274 (18.7%)	< 0.001	6,390 (20.8%)	20,146 (20.3%)	0.2218	26,536 (20.5%)
2 to 3	1,203 (9.1%)	1,100 (6.3%)		2,303 (7.5%)	7,608 (7.7%)		9,911 (7.6%)
4 to 7	93 (0.7%)	66 (0.4%)		159 (0.5%)	483 (0.5%)		642 (0.5%)
Frequency of Portal Logins, n (%)							
Range (Mean)	1 to 1519 (42.1)	1 to 800 (13.9)		1 to 1519 (52.0)			
Light (1 to 3 Logins)	1,536 (11.7%)	7,878 (45.0%)		9,414 (30.7%)			
Moderate (4 to 27 Logins)	6,320 (47.9%)	7,416 (42.4%)	< 0.001	13,736 (44.8%)	N/A	N/A	N/A
Heavy (28+ Logins)	5,326 (40.4%)	2,217 (12.7%)		7,543 (24.6%)			
Time Between Initial Code Generation & Portal Activation, n (%)							
Range (median)	36 seconds to 6.1 yrs. (6.1 days)	0 minutes to 5.9 yrs. (6.1 days)		0 minutes to 6.1 yrs. (6.1 days)			
Fast (0 mins to 2.1 hours)	2,681 (20.3%)	4,530 (25.9%)	< 0.001	7,211 (23.5%)	N/A	N/A	N/A
Moderate (2.2 hours to 136 days)	7,023 (53.3%)	8,591 (49.1%)		15,614 (50.9%)			
Slow (>136 days)	3,474 (26.4%)	4,384 (25.0%)		7,858 (25.6%)			
Time Between First Portal Usage & First MPC usage							
Range (median)	12 seconds to 3.6 years (106.2 days)						
Fast (20 seconds to 2.1 days)	3,296 (25.0%)	N/A	N/A	N/A	N/A	N/A	N/A
Moderate (2.2 days to 476 days)	6,590 (50.0%)						
Slow (477+ Days)	3,296 (25.0%)						

Notes: Patient IDs marked to two or more races and with the same age: 4063, resulting in 2078 duplicate IDs which were removed from the total N. Age: Ages 90 or greater were marked as >90 in original data set; these were converted to 90. Sex: 5 Unknowns/Nulls were scrubbed from the data. Race: original "Unknown/Declined/ Null" statuses were: Not Collected/Unavailable/ Unknown/Declined/Null. Among the reasons these statuses exist at all: not all patients were asked about Race at time of data collection, and some declined to answer. De-duped patient IDs which had selected more than one race were treated as Race="Many Race". "Other Race" refers to a long list of other selectable races (Native American, Alaskan, Native American, etc.). Ethnicity: three entries marked as "White" were removed from the total. Original statuses for Ethnicity = "Unknown/Declined/Null": Not Collected/Unknown/ Declined/Null. Original statuses for Language = "Unknown/Declined/Null": Not Collected/Unknown/Declined/Null/Other Language. For Clinic Encounters, patient visits to different providers and/or clinics in the same day were counted separately. Time Between Initial Code Generation & Portal Activation: 10 discarded from total due to a) some active patients had no code ever generated, due to portal having been launched in 2009; b) patients with a pattern of code receipt, activation, then a dormant receipt again, which called into question whether they had really ever logged in, if a provider had done it on their behalf, etc.

3a-1. All Patients: Demographics

As Table 1 shows, a total of 129,738 IFH patients were considered for the study, based on the exclusion criteria specified, and after de-duplication of patients who had indicated more than one race. Median age of patients was 38, with 76.8% under 53; females comprised 60.7% of the population. As the demographics make clear, patient population is dominated by disadvantaged groups with respect to race, ethnicity and insurance coverage.

A sub-analysis of ethnicity and race was performed to add insight into the 'Other' Race category and the "Not Hispanic" race category and thereby gain more information about the study sample's racial and ethnic profile. This was performed by constructing a new variable pairing a Race category with an Ethnicity category.

Using this method, of the 61% identified as Not-Hispanic, 26,252 (33%) were discovered to be Black (Table 2). We also find that 48.5% of all patients are disadvantaged (Black-Other, Black-Not Hispanic, Black-Hispanic, Other-Hispanic, White-Hispanic, Unknown-Hispanic), 33.0% White (White-Not Hispanic, White-Other), and 18.4% Other (Other-Not Hispanic, Other-Other, Unknown-Other, Unknown-Not Hispanic).

3a-2. All Patients: Co-Morbidities

The study period is rather long (2/2011 to 9/2014), so the clinic visits variable alone doesn't give us a strong indication of the overall morbidity and chronic-condition load of the population, which we expect to be higher than average, given IFH is a network of FQHCs serving a safety net population. For this reason, chronic disease load (based on ICD9 problem list code), in addition to Aggregated Diagnosis Groups (part of the Johns Hopkins Adjusted Clinical Groups® System (97)), were used to gain further insight into population health. As the Johns Hopkins site indicates, "each ADG is a grouping of diagnosis codes that are similar in terms of severity and likelihood of persistence of the health condition over time."

Fifty-three percent of all patients had one or more chronic conditions, 32.5% had one or two conditions, 13.1% had three to four, and 7.4% had five to seventeen. In terms of major ADG count, 71.4% had a zero, 20.5% had one, 7.6% had two to three, and 0.5% had 4 to 7.

It should be noted that a disparity exists between chronic conditions and ADG count; ADG count only looks at the number of major Aggregated Diagnostic groups applicable to each patient. A patient could have several chronic conditions which, as a bundle, don't satisfy one of the 32 sets of criteria to qualify as an ADG group. The ADG count should therefore be considered an indicator of greater co-morbidity than the chronic conditions.

3b-1. MyChart (Patient Portal) Use

30,693 patients used the patient portal during the study period, or 23.7% of all patients studied, with usage here defined as any time-stamped login (Table 1, below). Range of portal use was from 1 to 1519 logins; mean among all portal users was 52. Of all portal users, 44.8% were moderate portal users, logging in between four to 27 times during the study period; Heavy users (28+ logins) constituted 24.6% of all portal users, and light users (1-3 logins) made up 30.7% (Table 1). Significant right skew was observed for portal logins, with the average portal logins of the Heavy user groups at 78.9; in addition, kurtosis was 119.126, indicating a significantly non-normal and peaked distribution.

Time between initial code generation and portal activation was analyzed as well, in an attempt to discover motivation levels among patients and possible ties to more engaged uses of the portal (i.e., MPC). This analysis revealed that, among all portal users, median time to activate was 6.1 days. Significant right skew in portal activation (some took as long as 6.1 years) was present. Nearly half (50.9%) of all portal users

took between 2.2 hours to 138 days to activate their portal accounts after having an access code generated and e-mailed to them; 25.6% took 136 or more days, and 23.5% were "Fast" activators, taking anywhere from 0 minutes to 2.1 hours, suggesting they may have activated their account while in the clinic.

3b-2. Patient Portal Use: Demographics

Median age for portal users (34) was younger than that of non-portal users (39). Chi-squared tests were used to test for statistical significance among portal vs. non-portal groups. Younger portal users (18-27 and 28-38) comprised a larger percentage of portal-using patients than they did non-portal users (60.4% of portal users vs. 48.7% of all non-portal users, $P < 0.001$), with the 18-27 bracket making up 31.6% of all portal users, but only 26.3% of all non-portal users ($P < 0.001$). Female users, already making up 60.7% of all patients, make up an even larger percentage of total portal users, but fewer non-portal users (67.5% of portal users vs. 58.5% of non-portal users, $P <0.001$).

In terms of race, as expected, white patients use the portal more often than other races, making up 38% of all portal users. Black patients make up 22.0% of all portal users vs. 23.2% of non-portal users ($P<0.001$). The "Other & many race" category of patients makes up 26.8% of all non-portal users and 27.6% of portal users ($P <0.001$); stratification of this category (Table 2) reveals that 25,175 of this category is Hispanic (25,175 out of 35,043, or 71.8%).

Hispanics make up 27.1% of all non-portal users and 26.9% of portal users ($P<0.001$), while Non-Hispanics make up a greater proportion of portal users (63.6%) than they do non-portal users (60.2%, $P<0.001$). A stratification of ethnicity by race, using a Race-Ethnicity variable, reveals that, of the Non-Hispanic group, 20.2% of all patients are Black-Not Hispanic; this group comprises 20.5% of all non-portal users but only 19.5% of all portal users ($P<0.001$). The other major sub-group of ethnicity as non-Hispanic is the White-Not Hispanic group, which makes up 32.1% of all patients, and 31.4% of non-portal users vs. 34.3% of portal users ($P=0.001$).

93.9% of portal users chose English as their preferred language, an increase in proportion compared to the percentage of all non-portal using English speakers (84.1%, $P < 0.001$). Only 3.8% of all portal users chose Spanish as their preferred language, vs. 9.6% of all non-portal users ($P < 0.001$); Spanish speakers upon ethnicity stratification (Table 3) were found to be almost completely Hispanic (10,080 out of 10,624, or 94.9%). Meanwhile, ethnicity stratification against English speakers (who comprise 86.4% of all patients (112,118 out of 129,738)), revealed that Hispanic English speakers, while constituting 19% of all patients, make up 17.7% of non-portal users vs. 23.1% of portal users ($P<0.001$), a sizable shift in proportion.

Likewise, the non-Hispanic English speaker group increases from 58.5% of all non-portal users to 62.9% of portal users ($P<0.001$). It is worth noting that the increase in percentage for Hispanic English speakers who use the portal when compared to Hispanic English-speaking non-portal users is on par with, and even greater than the expected increase in among non-Hispanic English speakers.

3b-3. Patient Portal Use: Insurance, Clinic Usage and Co-Morbidities

Regarding insurance coverage, commercially insured patients increase as a proportion of total from 20.3% of all non-portal users to 32.8% of portal users ($P<0.001$), an expected shift given prevailing disparities with regard to health/tech literacies. Medicaid, dual-eligibles and uninsured patients separately and in aggregate experience a decrease in percentage of total when comparing non-portal users to portal users (Aggregate for these three encounter coverage types: 63.8% of all non-portal users vs. 55.4% of portal users, $P<0.001$).

Of the variables concerned with co-morbidity and usage of IFH services (in-office encounters, chronic conditions and ADG count), most showed that as usage of services and co-morbidities increases, portal use increases as well. For example, 42% of patients visiting clinics only 1 or 2 times ("light" clinic users) were non-portal users, but 20.9% were portal users ($P<0.001$); conversely, "moderate" and "heavy" clinic users (three to ten visits and eleven or more visits per patient) made up 57.9% of all non-portal users, but a sizable 79.1% ($P<0.001$) of all portal users.

While analysis of ADG counts between portal users and non-portal users revealed very little difference in proportion (for example, 71.5% of portal users were those with zero ADG count; 71.2% of non-portal users were in the same ADG group; $P = 0.2218$), analysis by chronic condition count suggested that more chronically ill patients used the portal more. Patients with no chronic conditions made up 48.9% of all non-portal users; they only made up 41.1% of portal users ($P<0.001$). Conversely, the sickest patients (those with three to seventeen chronic conditions) comprised

20.1% of all non-portal users, but 21.8% of all portal users (P<0.001), a statistically significant shift.

3c-1. MedlinePlus Connect (MPC) Use

13,182 patients used MPC during the study period, or 42.9% of all portal users (for the purposes of this study, MPC users were all also portal users), and 10.2% of all patients. MPC usage is defined as any click on a hyperlinked MPC object (problem list diagnosis or medication, most commonly) in their patient portal. Range of MPC usage count per patient was from 1 to 110 MPC searches; mean among all MPC users was 3.7 MPC searches, median was two indicating right skew. Of all MPC users, 75% searched four or fewer times, with 50% searching two or fewer times.

Time between initial code generation and portal activation was analyzed, revealing that 20.3% of MPC users were "Fast" activators of their patient portals, compared to 25.9% of non-MPC users (P<0.001); 23.5% of all portal users were "Fast" activators. Time between first portal usage and first MPC usage was also analyzed, with the assumption being that those who quickly used MPC upon portal activation are more engaged with their health. This analysis found that 50% of all MPC users waited a moderate amount of time (2.2 to 476 days), 25% were fast first-MPC users (20 seconds to 2.1 days), with slow first-time MPC users (477+ days between portal activation and MPC use) constituting the other 25%.

3c-2. MPC Use: Demographics

MPC users were on par with portal users in terms of median age (both 34), both younger than median age for all users (38). Younger users (18-27) made up 29.7% of all MPC users, compared to non-MPC users (33.0%, P<0.001). This reflects an increase compared to all patients (27.6% of total), but a decrease compared to all portal users (31.6% of total). Those 53 or older represented a larger proportion of MPC users than non-MPC users (16.3 vs. 15.7% respectively, P<0.001). Females again outnumbered males, constituting 70% of all MPC users (compared to 65.6% of non-MPC users, P<0.001).

Black patients constituted 22.4% of all MPC users vs. 21.7% of all non-MPC users (P=0.0007); white patients made up 36.7% of all MPC users, an increase compared to their percentage of all patients (35.8%), but a decrease compared to white non-MPC users (39.0%). The "other race & many race" category (72% of which is shown above, via stratification, to be Hispanic) made up 28.3% of all MPC users, compared to 27.1% of non-MPC users. A similar trend occurs when analyzing Hispanic ethnicity, with 27.7% of all MPC users registering as such, vs. 26.2% of all non-MPC users (all race MPC vs. non-MPC comparisons: P=0.0007; P=0.0094 for ethnicity comparisons).

94.9% of all MPC users marked their preferred language as English, compared with 93.1% of non-MPC users (P<0.011), 93.9% of all portal users and 86.4% of all patients. Stratification of language by ethnicity reveals that of the 12,510 MPC users (out of 13,182) who marked Preferred Language as English, 3,269 (24.8% of all MPC users) are Hispanic, compared with 21.8% of all non-MPC users (P<0.001), and

compared with 19.0% of all patients. It is worth noting that the percentage of all users who are Spanish speakers drops from 8.2% of all patients to 3.8% of all portal users, and further, 3.0% of all MPC users.

3c-3. MPC Use: Insurance, Clinic Usage and Co-Morbidities

Medicaid, dual-eligibles and self-pay constituted 61.9% of all patients' encounter insurance and 55.9% of that of all portal users; these insurance types together constituted 55.8% of all MPC users' insurance vs. 55.1% of all non-MPC users' insurance ($P = 0.0004$). Commercially insured patients made up 32.8% of MPC users, the same percentage as non-MPC users. This is also the same as the proportion of portal users (32.8%), and significantly larger than the proportion of all patients, where commercially insured patients made up 23.3% of all patients (All MPC vs. non-MPC comparisons regarding insurance coverage: $P=0.0004$).

Median and mean office encounters for MPC patients were 7 and 13, on par with all portal users, with both being higher than these same central measures for all patients (4, 9.8). Those patients classified as "Heavy" clinic visitors (11+ visits) constituted 43.1% of all MPC users and only 29.5% of non-MPC users ($P<0.001$).

Mean chronic conditions were highest among MPC users (1.8) vs. non-MPC users (1.3), Portal users (1.5) and all patients (1.4). 26.5% of all MPC users had 3 or more chronic conditions, compared with 18.4% of all non-MPC users ($P<0.001$). Similarly, 9.8% of all MPC users had 2 to 7 for ADG count, compared with 6.7% of non-MPC users ($P<0.011$), 8.0% of portal users and 8.1% of all patients.

3c-4. MPC Use: English vs. Spanish URL

IFH ensured that Spanish-speaking patients had access to the Spanish version of MyChart. This meant that a Spanish-speaking portal user was also able to access a Spanish-version of MedlinePlus by clicking on their MPC health objects. Unfortunately, due to a URL truncation error, data on patients who were Spanish speakers and who clicked on MPC objects is missing prior to June 30, 2013. No meaningful frequencies or analyses could therefore be performed on English vs. Spanish MPC usage (aggregations of topics searched for by language, etc.).

The tracking URL issue was, however, resolved on 6/30/2013, so analysis was possible from this date to the end of the study period (9-20-2014). 16,794 MPC searches were performed during this "URL fix" period, with 273 traceable to Spanish-enabled portal users (1.6%), 16,521 traceable to English-enabled portal users (98.4%).

Table 2: Stratification of Race and Ethnicity based on Usage of Race-Ethnicity Variable

Patient Characteristics	Used MPC at least once n=13,182 (42.9% of Portal Users)	Never used MPC n=17,511 (57.1% of Portal Users)	P	All Portal Users n = 30,693 (23.7% of All Users)	All Non-Portal Users n= 99,045 (76.3% of All Users)	P	All Users n = 129,738
Race+Ethnicity							
Disadvantaged							
Black-Other	132 (1.0%)	161 (0.9%)		293 (1.0%)	1,342 (1.4%)		1,635 (1.3%)
Black-Not Hispanic	2,635 (20.0%)	3,358 (19.2%)		5,993 (19.5%)	20,259 (20.5%)		26,252 (20.2%)
Black-Hispanic	188 (1.4%)	277 (1.6%)		465 (1.5%)	1,422 (1.4%)		1,887 (1.5%)
Other-Hispanic	2,605 (19.8%)	3,289 (18.8%)	0.241	5,894 (19.2%)	19,281 (19.5%)	<0.001	25,175 (19.4%)
White-Hispanic	379 (2.9%)	417 (2.4%)		796 (2.6%)	2,751 (2.8%)		3,547 (2.7%)
Unknown-Hispanic	486 (3.7%)	603 (3.4%)		1,089 (3.5%)	3,384 (3.4%)		4,473 (3.4%)
Sub-Total	**6,425 (48.7%)**	**8,105 (46.3%)**		**14,530 (47.3%)**	**48,439 (48.9%)**		**62,969 (48.5%)**
White							
White-Not Hispanic	4,327 (32.8%)	6,186 (35.3%)		10,513 (34.3%)	31,138 (31.4%)		41,651 (32.1%)
White-Other	133 (1.0%)	226 (1.3%)	0.133	359 (1.2%)	860 (0.9%)	0.001	1,219 (0.9%)
Sub-Total	**4,460 (33.8%)**	**6,412 (36.6%)**		**10,872 (35.4%)**	**31,998 (32.3%)**		**42,870 (33.0%)**
Other							
Other-Not Hispanic	1,054 (8.0%)	1,380 (7.9%)		2,434 (7.9%)	6,867 (6.9%)		9,301 (7.2%)
Other-Other	72 (0.5%)	78 (0.4%)		150 (0.5%)	417 (0.4%)		567 (0.4%)
Unknown-Other	909 (6.9%)	1,223 (7.0%)	0.429	2,132 (6.9%)	9,962 (10.1%)	<0.001	12,094 (9.3%)
Unknown-Not Hispanic	262 (2.0%)	313 (1.8%)		575 (1.9%)	1,362 (1.4%)		1,937 (1.5%)
Sub-Total	**2,297 (17.4%)**	**2,994 (17.1%)**		**5,291 (17.2%)**	**18,608 (18.8%)**		**23,899 (18.4%)**

Table 3: Stratification of Preferred Language on Ethnicity

Patient Characteristics	Used MPC at least once n=13,182 (42.9% of Portal Users)	Never used MPC n=17,511 (57.1% of Portal Users)	P	All Portal Users n = 30,693 (23.7% of All Users)	All Non-Portal Users n= 99,045 (76.3% of All Users)	P	All Users n = 129,738
Preferred Language							
English	**12,510 (94.9%)**	**16,304 (93.1%)**		**28,814 (93.9%)**	**83,304 (84.1%)**		**112,118 (86.4%)**
Hispanic	3,269 (24.8%)	3,819 (21.8%)	<0.001	7,088 (23.1%)	17,536 (17.7%)	<0.001	24,624 (19.0%)
Not Hispanic	8,195 (62.2%)	11,111 (63.5%)		19,306 (62.9%)	57,904 (58.5%)		77,210 (59.5%)
Not Collected/NULL	1,046 (7.9%)	1,374 (7.8%)		2,420 (7.9%)	7,864 (7.9%)		10,284 (7.9%)
Spanish	**389 (3.0%)**	**769 (4.4%)**		**1,158 (3.8%)**	**9,466 (9.6%)**		**10,624 (8.2%)**
Hispanic	375 (2.8%)	750 (4.3%)		1,125 (3.7%)	8,955 (9.0%)		10,080 (7.8%)
Not Hispanic	8 (0.1%)	5 (0.0%)	0.110	13 (0.0%)	163 (0.2%)	<0.001	176 (0.1%)
Not Collected/NULL	6 (0.0%)	14 (0.1%)		20 (0.1%)	348 (0.4%)		368 (0.3%)
Other	**46 (0.3%)**	**56 (0.3%)**		**102 (0.3%)**	**659 (0.7%)**		**761 (0.6%)**
Hispanic	3 (0.0%)	3 (0.0%)	0.795	6 (0.0%)	49 (0.0%)	0.531	55 (0.0%)
Not Hispanic	40 (0.3%)	51 (0.3%)		91 (0.3%)	558 (0.6%)		649 (0.5%)
Not Collected/NULL	3 (0.0%)	2 (0.0%)		5 (0.0%)	52 (0.1%)		57 (0.0%)
Declined/Unknown/Null	**237 (1.8%)**	**382 (2.2%)**		**619 (2.0%)**	**5,616 (5.7%)**		**6,235 (4.8%)**
Hispanic	11 (0.1%)	14 (0.1%)		25 (0.1%)	298 (0.3%)		323 (0.2%)
Not Hispanic	35 (0.3%)	70 (0.4%)	0.458	105 (0.3%)	1,001 (1.0%)	0.334	1,106 (0.9%)
Not Collected/NULL	191 (1.4%)	298 (1.7%)		489 (1.6%)	4,317 (4.4%)		4,806 (3.7%)

Notes:"Not Collected/Null" category maps to the following dataset categories: Not Collected, Unknown, NULL, Declined, White. Also, Chi-squared tests used for the English speaker section; remaining three sections, due to sample size, were analyzed using Fisher's exact at 95% alpha.

3d-1. Bivariate Results - Correlation tests

Correlation analyses were performed using scatterplots and Spearman's rank correlation tests to assess exploratory correlations between patient portal use (operationalized as at least one distinct login by a patient), clinic visits among patient portal users (at least one clinic visit by a portal using patient), and MPC usage among patient portal users (operationalized as zero or more MPC clicks by a patient). For this exercise, n = 30693 (the population of all portal users) for all three vectors. Spearman's rank correlation test was chosen due to the presence of significant right skew in all three variables, as well as outliers.

The correlation plots were performed first to assess visual correlation. Varying degrees of positive correlation were observed between variables plotted, an expected

finding in all cases: we would expect that those who use the clinic more might use their portals more and/or use MPC more; likewise, we expect that those who use their patient portals more would use MPC more. The chi-squared tests in fact confirm this, with moderate and heavy clinic visitors and portal users associated with more MPC use than non-MPC users (Table 1).

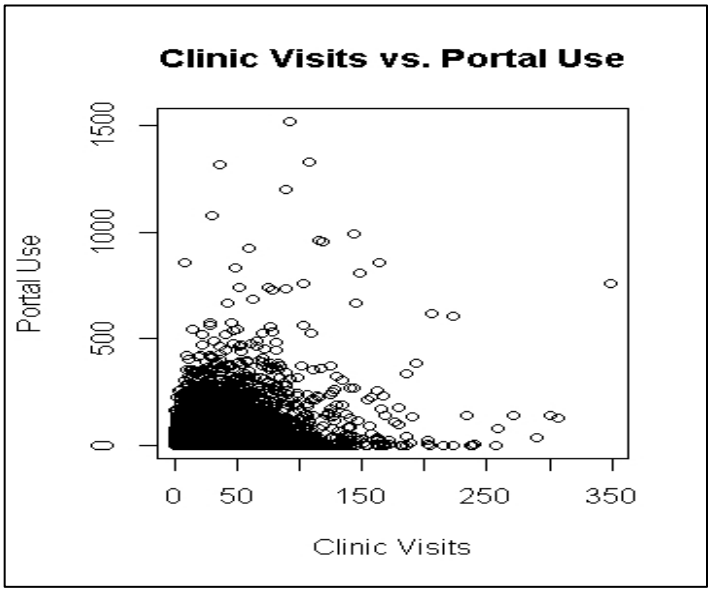

Figure 6: Bivariate Correlation: IFH Clinic visits vs. Patient Portal Use

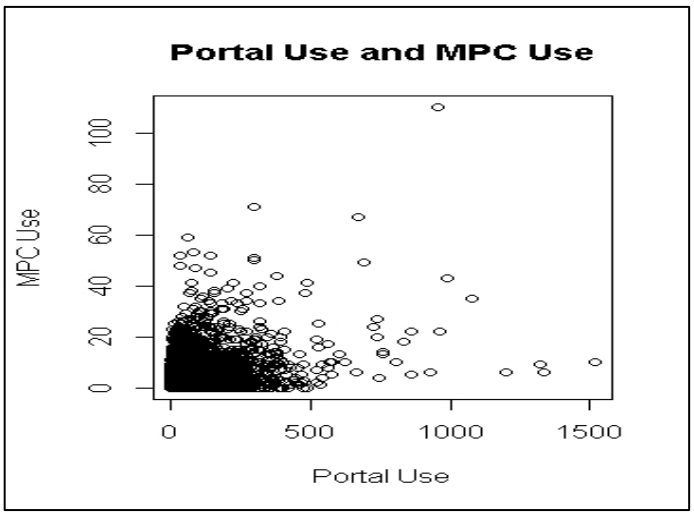

Figure 7: Bivariate Correlation: Patient Portal Use vs. MPC Use

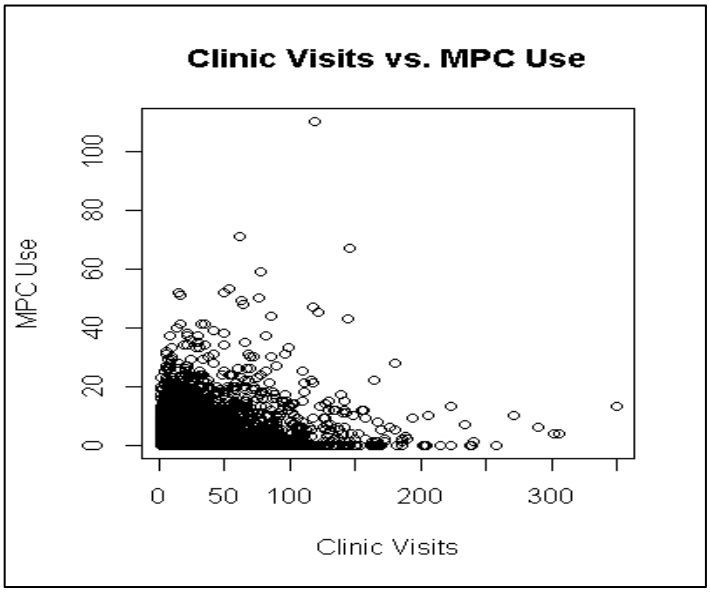

Figure 8: Bivariate Correlation: IFH Clinic visits vs. MPC Use

Correlation was moderate (rho = 0.366, P<0.001) between clinic visits and portal use (Fig. 6), stronger between portal use and MPC use (rho = 0.480, P<0.001, Fig. 7), and weakest between clinic visits and MPC use (rho = 0.232, P<0.001, Fig. 8).

These correlations and plots, while confirming chi-squared test findings, also demonstrate the heavy right skew of the metrics involved, with a small clutch of patients utilizing clinic and portal-related services to an unusual degree, in many cases featuring patients who, despite being heavy portal users, still needed to visit clinicians in person to get health and medical needs met.

3d-2. Multiple Logistic Regression

Multiple logistic regressions were used to determine predictors of MPC usage among portal users. We hypothesized that being in a traditionally disadvantaged group would be associated with lower likelihood of using MPC. We also hypothesized that women, younger patients, activated patients and unhealthy patients would use MPC more. Finally, based on chi-squared results and the correlation tests, we hypothesized that clinic visits and portal use would be predictors of MPC use.

After hypothesis-driven variable selection was performed, univariate analyses were performed against each variable of interest to establish unadjusted performance. Before other variables were addressed, we operationalized our "disadvantaged" variable by identifying and aggregating all patients who self-paid, were on Medicaid or were dual-eligible as one group, and all other patients as another group. Based on results of chi-squared tests and preliminary univariate logistic regression (and, to a lesser extent, comparison of McFadden's pseudo-R^2) this method of designating disadvantageousness (which we labeled in the final models simply as "poverty") was found to be a stronger covariate choice than ethnicity, race, preferred language, or any one of the insurance coverage variables alone.

We then explored patient unhealthiness, operationalized as ADG count and chronic disease count (see Table 1 for chi-squared results). Neither of these variables made it into the final model, though both are noted below in the unadjusted section of Table 4. Age was left as a continuous variable (18 to 90), while patient activation was

operationalized as portal use (login count; continuous). Count of clinic visits was also explored as a continuous variable.

Table 4 shows the final unadjusted and adjusted results for each chosen predictor of MPC use. Unadjusted values reflect the initial univariate regression analyses, while adjusted values reflect those that were used in the final model, which controlled for poverty, sex (as female), age, and portal use, dropping chronic disease count, ADG count and clinic visits due to their negative statistical impact.

The adjusted model shows that being poor made a patient 6.7% more likely to use MPC (P=0.0072), while being male makes a patient 13.1% less likely of MPC use (P<0.0001). All variables were statistically significant in the final model.

Collinearity was likely between the variables discarded and those that were used in the final model; for instance, the measures of health (chronic disease count, ADG) were likely at least somewhat collinear with portal use and age, given that older patients are likely to be sicker, and those with more chronic conditions, as shown in the chi-squared results (Table 1) are more likely to be portal users than non-portal users.

Table 4: Predictors of MPC Usage

	(Unadjusted)			(Adjusted)		
Predictor	**OR**	**95% CI**	**P Value**	**OR**	**95% CI**	**P Value**
Poverty	1.032	(0.986, 1.080)	0.1790	1.067	(1.018, 1.118)	0.0072
Sex (Male)	0.869	(0.827, 0.912)	<0.0001	0.821	(0.775, 0.870)	<0.0001
Age (every 1 year)	1.001	(0.999, 1.002)	0.3920	1.004	(1.001, 1.006)	0.0019
Portal Use (No. of Logins)	1.000	(1.000, 1.001)	0.3020	0.999	(0.999, 1.000)	0.0167
Chronic Disease Count	1.004	(0.992, 1.016)	0.5450	-	-	-
ADG Count	0.970	(1.032, 1.001)	0.9560	-	-	-
Clinic Visits	0.998	(1.001, 1.000)	0.5420	-	-	-

Notes: Abbreviations: CI = Confidence Interval. OR = Odds Ratio. Results from Multiple Logistic regression using R.

4. DISCUSSION

4a. Analyses

This retrospective study of a large patient dataset from a network of federally qualified health centers used bivariate analyses to reveal differences in usage of MedlinePlus Connect on the bases of race, ethnicity, age, sex, language, insurance type, clinic usage, frequency of patient portal use, and health status. In addition, multiple logistic regression was used to discover poverty and sex as predictive of MPC use and non-use, respectively, each with statistical significance.

Some findings were in line with our hypotheses. For instance, being male was a strong and statistically significant predicator of not using MPC (Adjusted OR: 0.821 OR, CI 0.775 to 0.870, $P<0.001$); as hypothesized, females use MPC more than males. This makes sense considering IFH's overall sex distribution (primarily female), and its structure as a network of FQHCs consisting largely of family practitioners, where gynecological & contraceptive management visits by younger women are among the most frequent ICD9 codes assigned to clinic visits. These metrics are also consistent with larger national trends, where females are more likely to use healthcare services than males (98)(99), especially among Hispanics (100).

Bivariate analysis by patient activation and/or usage of IFH health services – here operationalized as in-office encounters, frequency of patient portal login, time between initial patient portal activation code and portal activation, and time between portal login and first MPC use (see Table 1) – showed mixed results when comparing

bivariate and multiple logistic regression analysis results. For example, using chi-squared tests, we found that among all MPC users, the heaviest clinic users (11+ visits over the study period) constituted 43.1% of all users; among all non-MPC users, this group only amounted to 29.5% (P<0.001). This expected finding seems to suggest that patients who are frequent visitors to IFH clinics are more likely to be engaged with their health, enough to utilize MedlinePlus Connect to search and learn about their health conditions and medications.

However, preliminary multiple logistic regression revealed clinic visits (as both a tiered and continuous variable) to be relatively neutral and statistically insignificant as a predictor of MPC use (Adjusted Clinic visits OR : 0.999, CI: 0.998 to 1.001, P 0.3002). Skewness of data here may have played a part in rendering this variable unfit as a predictor of MPC use. This mixed finding has face validity: it's not necessarily the case that patients who visit clinics often are necessarily technology- and health-literate enough to utilize a function such as MedlinePlus Connect more often than other patients.

Similarly, frequency of patient portal logins revealed an expected association between the heaviest portal users and MPC use (patients with 28+ logins constituted 40.4% of all MPC users, only 12.7% of non-MPC users, P<0.001). Conversely, those using the portal the least (1 to 3 logins) only constituted 11.7% of MPC users, and 45% of non-MPC users. These chi-squared results suggest, as hypothesized, that heavy usage of the gateway technology of the patient portal is associated with utilization of one of the most salient portal functions, MedlinePlus Connect.

However, the final multiple logistic regression model revealed that total portal logins per patient is very-slightly-negative as a predictor of MPC use, with its adjusted odds ratio dropping three thousandths of a point compared to the original OR (unadjusted OR: 1.0002, CI: 0.9997 to 1.0007, P = 0.302; adjusted OR: 0.999, CI: 0.9985 - 0.9998, P=0.0167). While a minor shift, this does indicate that, with this model, portal use would be very slightly predictive of a decrease in MPC use over time.

One possible explanation for this finding is that, in order to achieve Meaningful Use Stage 2 requirements, IFH at various points during this study period made it an organization-wide initiative to guide select patients through the portal code activation process, often at the time of visit, thus leading to many cases of a one-time login (5061 patients, or 16.5% of the 30,693 portal users) followed by cessation of portal usage. This explanation has face validity given that this safety net population, like most FQHC populations, had limited at-home internet connectivity, and other disparities-related challenges with consistent technology usage.

Further, in some cases, fast-tracked patients may have been less likely to 'stick' and remain active portal users. This is a finding in Ancker, et al. ("Use of an Electronic Patient Portal Among Disadvantaged Populations", 2011), who found that "those who activated their account the same day they received an access code were less likely to become repeat users." (72) Since MPC use is strongly associated with portal use (as demonstrated in the chi-squared and correlation tests), that could mean a proportion of fast-tracked patients will be much less likely to use MPC. Indeed, chi-squared test results (Table 1) demonstrate that of the fastest activators of the portal (0 minutes to

2.1 hours), 20.3% were MPC users, but 25.9% of them were *non*-MPC users (P<0.001).

Bivariate analysis by unhealthiness (operationalized as chronic condition count and ADG count) revealed significant association between unhealthiness and using MPC. For instance, those with 2 or more chronic conditions constituted 42% of MPC users, but only 31.1% of non-MPC users. Similarly, those with the highest ADG count (2-7) made up 9.8% of MPC users, but only 6.7% of non-MPC users. As one would expect, patients with greater degrees of unhealthiness are more likely to be engaged and interested in using a tool like MPC to learn more about their diagnoses and medications.

However, as is the case with several covariates analyzed in this study, multiple logistic progression did not corroborate the bi-variate findings. Both health variables were non-predictive of MPC use (example: for chronic conditions count, the unadjusted OR was 1.004, CI: 0.992 - 1.016, P = 0.545; adjusted OR: 1.003, CI: 0.991 to 1.015, P=0.6026). Sick patients may be more motivated to become engaged and curious about their health data, and be in the position to utilize MPC, but health literacy, technology literacy and other socioeconomic disparities can still act as barriers to use.

Some of our hypotheses were very clearly contradicted by the data. For instance, while initial frequency tallies showed that most MPC users were between 18 and 38 (58.9%, 39-53+, 41.1%), a chi-squared test on stratification by age level showed that older patients (53+) used MPC more than non-MPC users of the same age range (those 53 or older made up 15.7% of non-MPC users, but 16.3% of MPC users (P <0.001)).

This is contrary to our hypothesis that younger patients would be more likely to use MPC.

And while the multiple logistic regression model showed an adjusted OR for age that was little better than the null (1.001, CI 0.999 - 1.002, P=0.0019), a preliminary logistic regression model examining age as a four-tiered variable found the oldest tier (53+) to be predictive of MPC use (adjusted OR 1.077, CI 1.005 - 1.154, P = 0.0357), even though the tiered-age variable failed to be predictive among the other chosen covariates and was thus not used in the final model.

There is certain face validity to this: the older a patient, the more likely they are to face a significant chronic disease burden and the more likely they may be inspired to track and research their health, with or without the help of an aide, proxy, or the clinician him or herself. In fact, using patient data from the same network of FQHCs, Ancker, et al. showed ("Use of an Electronic Patient Portal Among Disadvantaged Populations", 2011), "older patients were less likely to receive portal access, but older patients who did receive portal access were actually more likely to activate the account." (72)

Perhaps our most compelling findings concerned disadvantaged populations and their use of MPC. Insurance encounter coverage is a powerful indicator of socioeconomic disadvantage, and bivariate analysis of this variable showed that those with commercial insurance constituted a greater percentage of portal users, MPC users and MPC non-users (32.8% for all three, P <0.001), vs. 23.3% of all patients). This was an expected finding: those with economic advantage are more likely to be health-

and technology-literate, and activated, all of which are preconditions for likelihood of using not just a patient portal but one of its specific functions, such as MPC.

However, the group of patients whose encounter coverage was either Medicaid, uninsured or dual-eligible constituted a *greater* proportion of all MPC users than non-MPC users (MPC Users: 55.8% vs. 55.1% of non-MPC users, P = 0.0004), or all portal users (55.4%). We expected to find that this bloc of patients used MPC less as a proportion of total, but in fact they used it at a rate not only on par with non-MPC users, but more often than non-MPC users as a percentage of total.

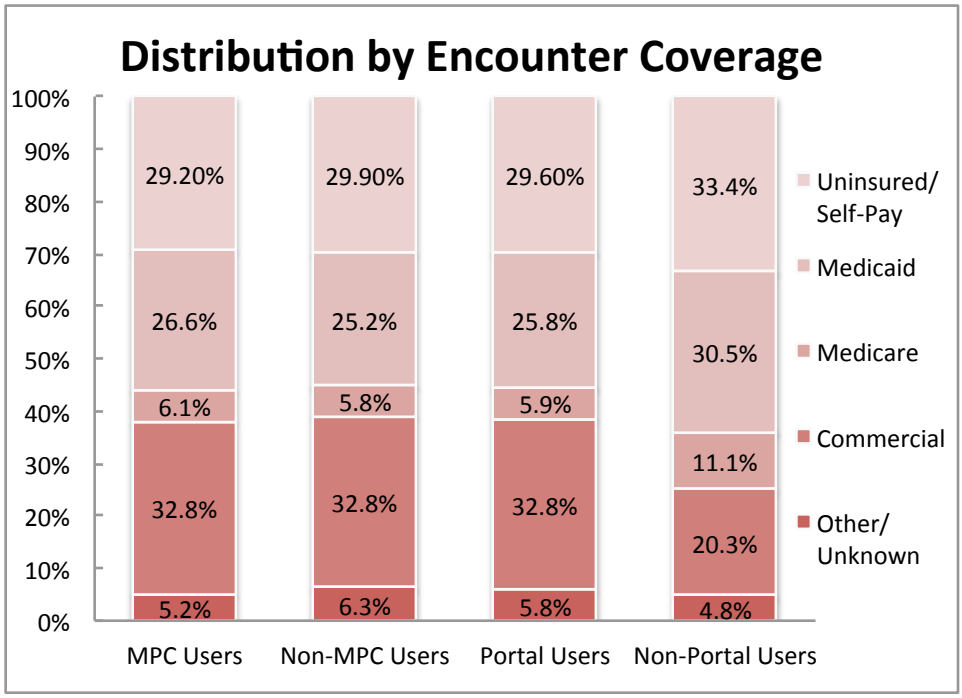

Figure 9 - Stacked Chart for Encounter Coverage, From Table 1

Bivariate analysis by race and ethnicity revealed similar results. As expected, white patients constituted a larger proportion of all MPC users than other races (36.7% of all MPC users were white, vs. 39.0% of non-MPC users, P<0.001). However, white patients made up a greater percentage of non-MPC users (39%, P=0.0007) and

portal users (38% of total). Conversely, the black and "other" race categories actually saw an *increase* in proportion of total when comparing MPC use (black patients = 22.4% of total, "other race" patients, 28.3%) to non-MPC Use (black patients = 21.7% of total, "other race" patients, 27.1% of total, all P = 0.0007).

Since race and ethnicity considered separately don't always give a complete picture of a population's demographic profile, stratification on a race+ethnicity variable was needed to further explore the data. This race-ethnicity stratification (Table 3) reveals that the "other" race category" is 69.8% Hispanic for MPC users (2605/3731), 69.3% Hispanic for non-MPC users (3289/4747) (MPC vs. non-MPC, P=0.241). This finding is echoed in the Ethnicity variable (Table 1), where chi-squared tests revealed that Hispanics represent a statistically significant (P=0.0094) difference in proportions between non-MPC users (26.2% of total) and MPC users (27.7% of total).

Chi-squared analysis of preferred language stratified by ethnicity (Table 3) revealed similar findings. With respect to language, though 94.9% of patients who used MPC were English speakers (12510), a greater proportion than non-MPC users (16304, 93.1%, P<0.001), 24.8% of all MPC users (3269) were Hispanic English speakers, vs. 21.8% (3819) of all non-MPC users (P<0.001). Once again, Hispanics are shown to not only drop off as a proportion of total MPC users, but actually increase in proportion vs. non-MPC users.

Sub-total analysis of the race-ethnicity variable is consistent with other findings. In a chi-squared analysis, blacks and Hispanics (Black-Other, Black-Not Hispanic, Black-Hispanic, Other-Hispanic, White-Hispanic, Unknown-Hispanic), considered in aggregate as "Disadvantaged", constituted 48.7% of all MPC users, vs. 46.3% of non-

MPC users (P>0.001 for MPC vs. non-MPC comparison); Whites (White-Not Hispanic, White-other) constituted 36.6% of all non-MPC users, and 33.8% of MPC users (P<0.001).

For the multiple logistic regression analysis, "poverty" (understood as insurance coverage being either Medicaid, uninsured or dual-eligible) was chosen as the most important covariate representing socioeconomic disadvantage (ahead of ethnicity, race, the novel race-ethnicity variable, and preferred language), and multiple logistic regression showed it to be predictive of MPC use, albeit slightly (Unadjusted OR: 1.03, CI: 0.99 to 1.08, P=0.1790; Adjusted OR:1.07, CI: 1.02 to 1.12, P=0.0072). This finding confirms the bivariate analyses already discussed: the most disadvantaged patients (with respect to insurance coverage, race, ethnicity and language) actually use MPC as much as, if not slightly more, than those who do not (Fig. 10, Fig.11, Tables 1-3).

We can conclude therefore that Medicaid and uninsured patients are not under-represented with respect to MPC use when compared with non-MPC users and portal users. In addition, we can also conclude based on these bivariate analyses that black and especially Hispanic patients, and various race-ethnicity permutations thereof, are *not* under-represented with respect to MPC use, but in some cases utilize MPC more often than non-disadvantaged populations with some statistical significance.

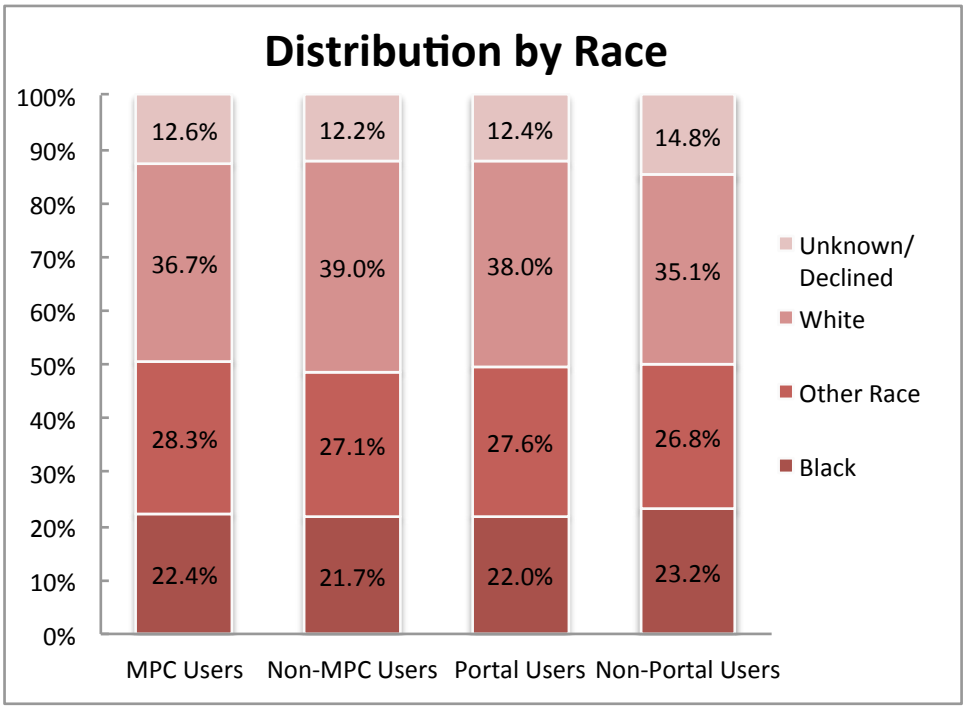

Figure 10 - Stacked Chart for Race, From Table 1

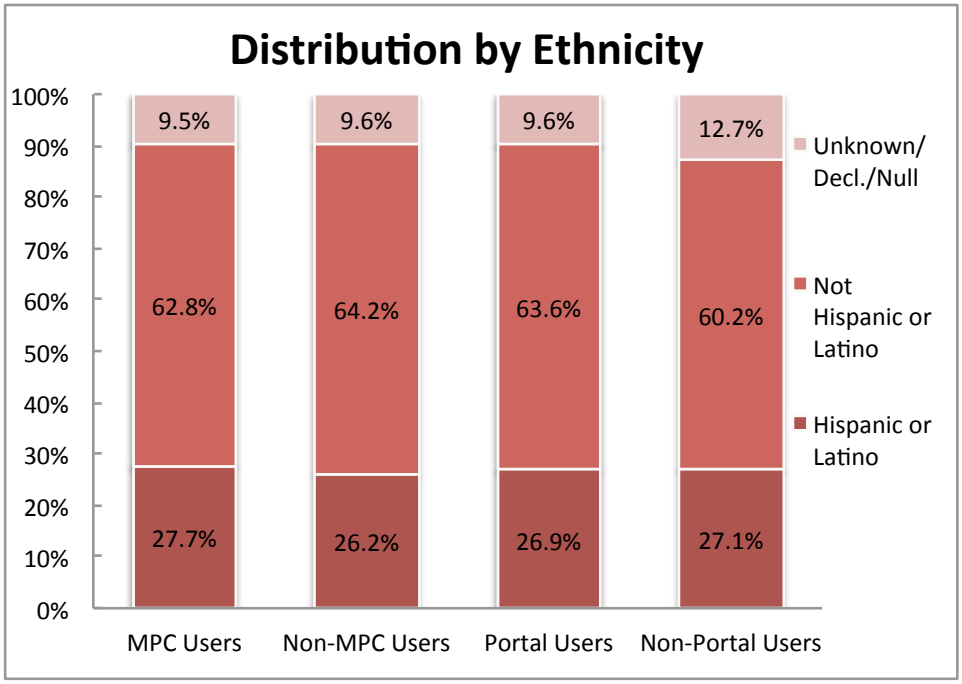

Figure 11 - Stacked Chart for Ethnicity, From Table 1

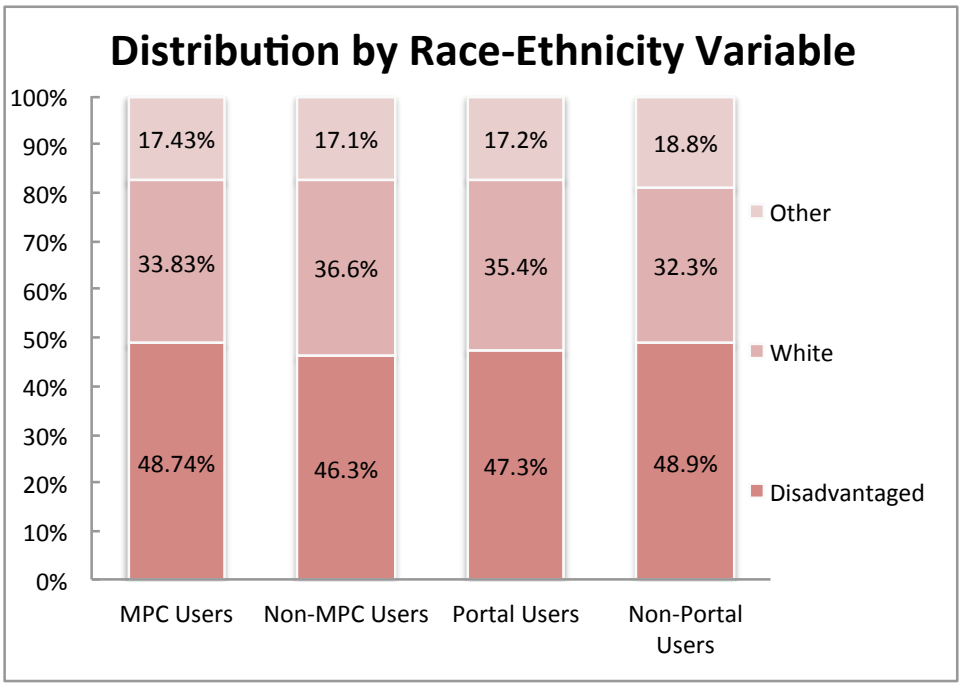

Figure 12 - Stacked Chart for Race-Ethnicity Variable, From Table 2

4b. Implications & Future Considerations

Our study showed that blacks, Hispanics and the medically under-insured were not only just as likely to use MPC as other patient groups, but in some cases, used them more often when compared to non-disadvantaged groups. Given the growing prevalence of chronic disease among minority and disadvantaged populations in this country, these findings are of special interest. Much has been made of the digital divide not only in the portal literature, but in health IT literature at large (28)(70)(82)(83). The problem of socioeconomically disadvantaged classes being left behind as technological advancement scales is a very real one. In this dataset, however, though the effect sizes are small, the same trend does not seem to be

occurring. This suggests that disadvantaged populations in this sample are not only inspired to use a medical information search tool embedded in a patient portal to learn about their health and medical information, but have the wherewithal to do so, despite socioeconomic indicators to the contrary.

Our study has shown that this was especially true for Hispanics, which is important given the chronic disease prevalence among Hispanics and the health outlook for this ethnicity group. For example, in 2011, Hispanic Americans were 1.2 times as likely to be obese than Non-Hispanic Whites; Hispanic adults were also 1.7 times more likely than non-Hispanic white adults to have been diagnosed with diabetes by a physician.(101)(102) Hispanics (especially men) are also less likely to have a regular health care provider, and less likely to feel they need health insurance.(100) A sizable proportion also get their health care info from TV and friends vs. certified health care providers ("83 percent" "report that they obtained health information from some branch of the media, with television being the dominant source"). Given the U.S. Hispanic population's projected growth rate (expected to double between 2015 and 2050, according to a 2014 Pew Research Center report (103)), the troubled Hispanic health profile becomes an even greater cause for concern.

As our country's major health concerns have shifted from episodic care to control and early prevention of chronic disease, patient engagement has been pointed to as a key resource in the effort to control and prevent chronic disease (104)(105)(106)(107)(108)(109)(110)(111). Specific patient portal usage such as the medical information search tool analyzed in this study are examples of such patient

engagement. Given our study's findings regarding disadvantaged populations' engagement with MPC, future considerations for research in this area might include an intervention and time-series study of usage of MPC. Such a study could examine how MPC as an intervention impacts mid-to-long term measures such as clinic visits (or other process measures), bio-measure changes, disease status, patient satisfaction, or other outcomes, such as patient engagement measures. Another research opportunity involves cohort studies where patients do and do not have provider help in interpreting or using patient portal functions, with patient satisfaction, patient engagement, patient outcomes, or even ROI as the outcome(s).

Our study could inform further portal development in environments where patient populations feature a large percentage of disadvantaged populations. For instance, peer support or peer mentoring modules could be introduced which utilize culturally relevant social media networking in an effort to control chronic disease or prevent it through lifestyle coaching. Also, dietary education modules could be embedded in the portal to inform the patient of culturally relevant healthy eating options. It's important to note, however, that all such online portal-based health interventions should have proper provider involvement. This will allow for proper conveyance of relevant health and medical data to the patient, integration of new information into an overall care plan, and solicitation of patient feedback to the provider to inform future improvements upon the portal functions (44)(59)(63)(65)(112).

Finally, there is a need to more deeply understand the sociotechnical context in which the portal interventions occur, and the mechanisms by which specific portal interventions achieve (or fail to achieve) hypothesized outcomes. As Ammenwerth, et

al. write in The Impact of Electronic Patient Portals on Patient Care: A Systematic Review of Controlled Trials (JMIR, 2012), "Studies in which a patient portal was combined with further services, such as secure messaging, interactive decision-support or health-related reminders, showed more positive impact on patient outcomes, patient-provider communication, disease management, and patient satisfaction, as a recent review of diabetes portals showed" (45). Otte-Trojel et al, in "How outcomes are achieved through patient portals: a realist review" (JAMIA, 2014), have done great work in this area, finding that, "as a complement to existing health services, patient portals can lead to improvements in clinical outcomes, patient behavior, and experiences. Four different mechanisms are reported to yield the reported outcome improvements. These are patient insight into personal health information, activation of information, interpersonal continuity of care, and service convenience." (41) These approaches, when properly applied to patient portal studies, can provide the necessary contextual analysis that will make generalizability to other clinical environments possible.

5. LIMITATIONS AND STRENGTHS

Our study is subject to several limitations. One limitation concerns the observational nature of our data and study design. This retrospective cohort study's design does not accommodate a time-series intervention-related component, where MPC use as an independent variable could be analyzed for a possible relationship to a change in a dependent variable, such a bio-measure (BMI, H1bAc test result), chronic condition count or ADG count, or even clinic usage over time. This would require in most cases more detailed data from IFH in order to gauge MPC impact and approximate (but prove) causality.

Another limitation is that, as of this writing, we were not able to make use of data concerning patient-friendly MPC terms. "Patient-friendly" in this context means the way the MPC hyperlinks appear to the patient in the Portal, which may differ from the actual encoded ICD9 and accompanying ICD9 diagnosis, the latter of which appears on the MPC search results page. An example of this might be the term "mood disorder", a patient-friendly term which, when clicked, actually leads to the problem list item the clinician had encoded (perhaps Depression (ICD9 311) and/or Anxiety (ICD9 300)). IMO, IFH and NLM worked together to create different patient-facing terms, the most common reason being to not alarm the patient/patient-proxies with potentially shame-producing diagnoses; in addition, lay language can allow for easier at-a-glance comprehension of a health condition. An analysis of patient-friendly MPC terms and their related metrics, especially when compared with the overall patient

problem list, could be important in telling us what language the patient actually clicked on, and whether the patient is more captivated by some patient-friendly terms than others. It may be that certain classes of lay-terms, even if not central to the patient's overall health and medical profile, are more compelling than others; it may be that some lay terms are or more or less effective in engaging the patient toward their most pressing health matters. It is a limitation of this paper that this aspect of MPC use goes unexplored, but this is certainly an area for other researchers to explore.

An additional limitation of this paper concerns numerous unmeasured confounders that very likely inform our findings. For instance, we had, as of this writing, limited-to-no access to the following variables: type of device used to access MyChart and MedlinePlus Connect (whether at-home computer, mobile device), patient activation level (either through PAM or some other measure), patient health literacy level, technology literacy level, nature of patient-provider relationship (i.e., whether patient is comfortable with clinician, can speak openly about problems, etc.), number and degree of clinician interventions in helping patients activate, log-in, test and learn MyChart and MPC. To varying degrees, all these confounders impact the degree to which this paper's analyses showed, or did not show, predictors of MPC usage and associations between its use and various patient characteristics and behaviors. For instance, knowledge about MPC users' baseline technological literacy level could help explain some of the strong usage frequencies seen in bivariate analyses. In addition, knowledge regarding the frequencies of smartphone vs. desktop use in this population could reveal interesting information about a safety-net population's usage of mobile

devices (which are cheaper and easier to set up and use than at-home desktop connections) to access and engage with important health information.

Among this paper's strengths are its study design and research question. As explored in the background section of this paper, much of the portal literature has focused on patient portal usage in aggregate (with a sub-segment focused on secure messaging), which has tended to limit the breadth and applicability of the analyses. With a complex health IT intervention such as a patient portal, existing as it does in such a variety of sociotechnical contexts, it's difficult to perform broad-stroke, macro analyses that lead to actionable findings, without sacrificing more granular learning. Our study, on the other hand, differs from the rest of the literature in that it appears to be the first in the U.S. to specifically focus on a medical information search function embedded within a patient portal.

In addition, many previous patient-portal related studies have focused on insured populations (52)(53)(113)(114), integrated health networks (Geisinger, Kaiser) (31)(36)(55)(66), or patients with a single chronic illness (44)(70)(115). Our study differs in that it is focused on a large, underserved population in a network of Federally Qualified Health Centers that features a high prevalence of chronic disease and which is very diverse socioeconomically, ethnically, and racially.

Our study also looks at the entire patient population who had at least one IFH clinic visit across a four year, seven month period. The size of our study sample helps reduce sample bias and helps power the analyses performed and the statistical conclusions drawn.

Finally, the race-ethnicity and language-ethnicity stratifications performed (Tables 3, 4) allow greater insight into the helpful but insufficiently granular Race and Ethnicity constructs. Our race-ethnicity stratifications call to mind the challenges that exist in working with the social-political and cultural constructs of race and ethnicity. This is especially true given the fluidity with which individuals comprehend and identify with these categories; indeed, according to the American Anthropological Association, "many residents of the United States consider race and ethnicity to be the same."(116)

6. CONCLUSION

Using bivariate and multiple logistic regression analyses, we can conclude that, consistent with our hypotheses, women, sick patients, heavy clinic visitors and heavy portal users were associated with MPC Use using bivariate analysis. Sex as male was a significant predictor of non-use of MPC using multiple logistic progression, while a patient's poverty level was found to be a predictor of MPC use.

We also conclude that, contrary to our hypothesis, minorities (especially Hispanics) and the socioeconomically disadvantaged are not under-represented among MPC users (with socioeconomic disadvantage operationalized by the variables race, ethnicity, stratification among race and language by ethnicity, and "poverty"). Indeed, Hispanics who use MPC constitute a greater percentage of total portal users than non-MPC users.

Six years after the passage of the HITECH Act in 2009, and the commitment of billions in U.S. federal funds incentivizing the widespread and meaningful adoption of HIT, there is still no clear consensus as to whether this financial and political investment is helping further the U.S. healthcare industry's "triple aim" of "ensuring access to quality health care while simultaneously targeting population health and cost containment"(117)(118)(119). As demonstrated in this study, this is especially true in the case of patient portals and their specific functions, where researchers are still determining the best ways to study if and how patient portal-related interventions work. Our study's examination of the use of a specific patient portal intervention by disadvantaged populations adds to the literature and to the HIT conversation by

showing that, at the very least, portal-related educational technology is being used more than anticipated by those who may need it most.

Collaborators: Dr. Jessica Ancker

Funding: Dr. Jessica Ancker's research with the Institute for Family Health has been funded by the Agency for Healthcare Quality and Research and the National Library of Medicine

7. WORKS CITED

1. Rezaee ME, Pollock M. Prevalence and Associated Cost and Utilization of Multiple Chronic Conditions in the Outpatient Setting among Adult Members of an Employer-based Health Plan. Popul Health Manag. 2015 Apr 28;150511141253004.

2. Ward BW, Schiller JS, Goodman RA. Multiple Chronic Conditions Among US Adults: A 2012 Update. Prev Chronic Dis [Internet]. 2014 Apr 17 [cited 2015 Apr 12];11. Available from: http://www.cdc.gov/pcd/issues/2014/13_0389.htm

3. Disparities F, Quartile T. 2014 National Healthcare Quality and Disparities Report. [cited 2015 May 17]; Available from: http://origin.www.ahrq.gov/research/findings/nhqrdr/nhqdr14/2014nhqdr.pdf

4. CDC - MMWR - MMWR Publications - Supplements: Current Volume (2013) [Internet]. [cited 2015 May 19]. Available from: http://www.cdc.gov/mmwr/preview/ind2013_su.html#HealthDisparities2013

5. Vulnerable Populations: Who Are They? [Internet]. [cited 2015 May 19]. Available from: http://www.ajmc.com/journals/supplement/2006/2006-11-vol12-n13suppl/nov06-2390ps348-s352/P-1

6. Smolen JR, Thorpe RJ, Bowie JV, Gaskin DJ, LaVeist TA. Health Insurance and Chronic Conditions in Low-Income Urban Whites. J Urban Health. 2014 Aug;91(4):637–47.

7. Lebrun LA, Chowdhury J, Sripipatana A, Nair S, Tomoyasu N, Ngo-Metzger Q. Overweight/obesity and weight-related treatment among patients in U.S. federally supported health centers. Obes Res Clin Pract. 2013 Sep;7(5):e377–90.

8. Zhang Q, Wang Y, Huang ES. Changes in racial/ethnic disparities in the prevalence of Type 2 diabetes by obesity level among US adults. Ethn Health. 2009 Oct;14(5):439–57.

9. Lochner KA, Cox CS. Prevalence of Multiple Chronic Conditions Among Medicare Beneficiaries, United States, 2010. Prev Chronic Dis [Internet]. 2013 Apr 25 [cited 2015 May 18];10. Available from: http://www.cdc.gov/pcd/issues/2013/12_0137.htm

10. Chronic Disease Overview | Publications | Chronic Disease Prevention and Health Promotion | CDC [Internet]. [cited 2015 May 19]. Available from: http://www.cdc.gov/chronicdisease/overview/index.htm/

11. Crossing the Quality Chasm: A New Health System for the 21st Century - Institute of Medicine [Internet]. [cited 2015 Mar 13]. Available from: http://www.iom.edu/Reports/2001/Crossing-the-Quality-Chasm-A-New-Health-System-for-the-21st-Century.aspx

12. Bayliss EA, Balasubramianian BA, Gill JM, Stange KC. Perspectives in Primary Care: Implementing Patient-Centered Care Coordination for Individuals with Multiple Chronic Medical Conditions. Ann Fam Med. 2014 Nov 1;12(6):500–3.

13. Maeng DD, Martsolf GR, Scanlon DP, Christianson JB. Care Coordination for the Chronically Ill: Understanding the Patient's Perspective. Health Serv Res. 2012 Oct;47(5):1960–79.

14. Zulman DM, Jenchura EC, Cohen DM, Lewis ET, Houston TK, Asch SM. How Can eHealth Technology Address Challenges Related to Multimorbidity? Perspectives from Patients with Multiple Chronic Conditions. J Gen Intern Med [Internet]. 2015 Feb 18 [cited 2015 May 20]; Available from: http://link.springer.com/10.1007/s11606-015-3222-9

15. Maly RC, Bourque LB. A randomized controlled trial of facilitating information giving to patients with chronic medical conditions: effects on outcomes of care. J Fam Pr. 1999;48(5):356–63.

16. Hibbard JH, Greene J. What The Evidence Shows About Patient Activation: Better Health Outcomes And Care Experiences; Fewer Data On Costs. Health Aff (Millwood). 2013 Feb 1;32(2):207–14.

17. Mosen DM, Schmittdiel J, Hibbard J, Sobel D, Remmers C, Bellows J. Is patient activation associated with outcomes of care for adults with chronic conditions? J Ambulatory Care Manage. 2007;30(1):21–9.

18. Greene J, Hibbard JH, Sacks R, Overton V, Parrotta CD. When Patient Activation Levels Change, Health Outcomes And Costs Change, Too. Health Aff (Millwood). 2015 Mar 1;34(3):431–7.

19. Gerteis, Margaret, Daley, Jennifer. Through the patient's eyes: understanding and promoting patient-centered care. San Francisco: Jossey-Bass; 1993.

20. Davis K, Schoenbaum SC, Audet A-M. A 2020 vision of patient-centered primary care. J Gen Intern Med. 2005 Oct;20(10):953–7.

21. Rao S, Brammer C, McKethan A, Buntin MB. Health Information Technology. Prim Care Clin Off Pract. 2012 Jun;39(2):327–44.

22. Kruse CS, Argueta DA, Lopez L, Nair A. Patient and Provider Attitudes Toward the Use of Patient Portals for the Management of Chronic Disease: A Systematic Review. J Med Internet Res. 2015 Feb 20;17(2):e40.

23. Gentles SJ, Lokker C, McKibbon KA. Health Information Technology to Facilitate Communication Involving Health Care Providers, Caregivers, and Pediatric Patients: A Scoping Review. J Med Internet Res. 2010 Jun 18;12(2):e22.

24. Sequist TD, Gandhi TK, Karson AS, Fiskio JM, Bugbee D, Sperling M, et al. A Randomized Trial of Electronic Clinical Reminders to Improve Quality of Care for Diabetes and Coronary Artery Disease. J Am Med Inform Assoc. 2005 Jul 1;12(4):431–7.

25. Pare G, Jaana M, Sicotte C. Systematic Review of Home Telemonitoring for Chronic Diseases: The Evidence Base. J Am Med Inform Assoc. 2007 May 1;14(3):269–77.

26. Chodosh, Joshua, Morton, Sally, Mojica, Walter. Meta-Analysis: Chronic Disease Self-Management Programs for Older Adults. Ann Intern Med. 2005;

27. Bauer AM, Thielke SM, Katon W, Unützer J, Areán P. Aligning health information technologies with effective service delivery models to improve chronic disease care. Prev Med. 2014 Sep;66:167–72.

28. Sarkar U, Karter AJ, Liu JY, Adler NE, Nguyen R, López A, et al. The Literacy Divide: Health Literacy and the Use of an Internet-Based Patient Portal in an Integrated Health System—Results from the Diabetes Study of Northern California (DISTANCE). J Health Commun. 2010 Aug 31;15(sup2):183–96.

29. Goldzweig CL, Orshansky G, Paige NM, Towfigh AA, Haggstrom DA, Miake-Lye I, et al. Electronic patient portals: evidence on health outcomes, satisfaction, efficiency, and attitudes: a systematic review. Ann Intern Med. 2013;159(10):677–87.

30. Palen TE, Ross C, Powers J, Xu S. ASsociation of online patient access to clinicians and medical records with use of clinical services. JAMA. 2012 Nov 21;308(19):2012–9.

31. Garrido T, Meng D, Wang JJ, Palen TE, Kanter MH. Secure E-mailing Between Physicians and Patients: Transformational Change in Ambulatory Care. J Ambulatory Care Manage. 2014;37(3):211–8.

32. Parnell TA, McCulloch EC, Mieres JH, Edwards F. Health Literacy as an essential component to achieving excellent patient outcomes [Internet]. Institute of Medicine of the National Academies; 2014 [cited 2015 May 19]. Available from: http://www.iom.edu/Global/Perspectives/2014/~/media/Files/Perspectives-Files/2014/Discussion-Papers/BPH-EssentialComponent.pdf

33. Improving outcomes in chronic illness. - PubMed - NCBI [Internet]. [cited 2015 May 19]. Available from: http://www.ncbi.nlm.nih.gov/pubmed/10157259

34. Wagner EH, Austin BT, Davis C, Hindmarsh M, Schaefer J, Bonomi A. Improving chronic illness care: translating evidence into action. Health Aff (Millwood). 2001;20(6):64–78.

35. Nagykaldi Z, Aspy CB, Chou A, Mold JW. Impact of a Wellness Portal on the delivery of patient-centered preventive care. J Am Board Fam Med. 2012;25(2):158–67.

36. Zhou YY, Kanter MH, Wang JJ, Garrido T. Improved Quality At Kaiser Permanente Through E-Mail Between Physicians And Patients. Health Aff (Millwood). 2010 Jul 1;29(7):1370–5.

37. Haun JN, Lind JD, Shimada SL, Martin TL, Gosline RM, Antinori N, et al. Evaluating User Experiences of the Secure Messaging Tool on the Veterans Affairs' Patient Portal System. J Med Internet Res. 2014 Mar 6;16(3):e75.

38. Kruse CS, Bolton K, Freriks G. The Effect of Patient Portals on Quality Outcomes and Its Implications to Meaningful Use: A Systematic Review. J Med Internet Res. 2015 Feb 10;17(2):e44.

39. De Lusignan S, Mold F, Sheikh A, Majeed A, Wyatt JC, Quinn T, et al. Patients' online access to their electronic health records and linked online services: a systematic interpretative review. BMJ Open. 2014;4(9):e006021.

40. Harris LT, Haneuse SJ, Martin DP, Ralston JD. Diabetes Quality of Care and Outpatient Utilization Associated With Electronic Patient-Provider Messaging: A Cross-Sectional Analysis. Diabetes Care. 2009 Jul 1;32(7):1182–7.

41. Otte-Trojel T, de Bont A, Rundall TG, van de Klundert J. How outcomes are achieved through patient portals: a realist review. J Am Med Inform Assoc. 2014 Jul 1;21(4):751–7.

42. Osborn CY, Mayberry LS, Mulvaney SA, Hess R. Patient Web Portals to Improve Diabetes Outcomes: A Systematic Review. Curr Diab Rep. 2010 Dec;10(6):422–35.

43. Ralston JD, Hirsch IB, Hoath J, Mullen M, Cheadle A, Goldberg HI. Web-based collaborative care for type 2 diabetes a pilot randomized trial. Diabetes Care. 2009;32(2):234–9.

44. Wade-Vuturo AE, Mayberry LS, Osborn CY. Secure messaging and diabetes management: experiences and perspectives of patient portal users. J Am Med Inform Assoc. 2013 May 1;20(3):519–25.

45. Ammenwerth E, Schnell-Inderst P, Hoerbst A. The Impact of Electronic Patient Portals on Patient Care: A Systematic Review of Controlled Trials. J Med Internet Res. 2012 Nov 26;14(6):e162.

46. Ammenwerth E, Schnell-Inderst P, Hoerbst A. Patient empowerment by electronic health records: first results of a systematic review on the benefit of patient portals. Stud Health Technol Inf. 2011;165:63–7.

47. Ross SE, Lin C-T. The Effects of Promoting Patient Access to Medical Records: A Review. J Am Med Inform Assoc. 2003 Mar 1;10(2):129–38.

48. Chen C, Garrido T, Chock D, Okawa G, Liang L. The Kaiser Permanente Electronic Health Record: Transforming And Streamlining Modalities Of Care. Health Aff (Millwood). 2009 Mar 1;28(2):323–33.

49. Miller DM, Moore SM, Fox RJ, Atreja A, Fu AZ, Lee J-C, et al. Web-Based Self-Management for Patients with Multiple Sclerosis: A Practical, Randomized Trial. Telemed E-Health. 2011 Jan;17(1):5–13.

50. Zhou, Yi Yvonne, Garrido, Terhilda. Patient Access to an Electronic Health Record With Secure Messaging: Impact on Primary Care Utilization. AJMC. 2007;

51. Bhavnani V, Fisher B, Winfield M, Seed P. How patients use access to their electronic GP record--a quantitative study. Fam Pract. 2011 Apr 1;28(2):188–94.

52. Sarkar U, Lyles CR, Parker MM, Allen J, Nguyen R, Moffet HH, et al. Use of the refill function through an online patient portal is associated with improved adherence to statins in an integrated health system. Med Care. 2014;52(3):194–201.

53. Wright A, Poon EG, Wald J, Feblowitz J, Pang JE, Schnipper JL, et al. Randomized Controlled Trial of Health Maintenance Reminders Provided Directly to Patients Through an Electronic PHR. J Gen Intern Med. 2012 Jan;27(1):85–92.

54. Staroselsky M, Volk LA, Tsurikova R, Pizziferri L, Lippincott M, Wald J, et al. Improving electronic health record (EHR) accuracy and increasing compliance with health maintenance clinical guidelines through patient access and input. Int J Med Inf. 2006 Oct;75(10-11):693–700.

55. Dullabh P, Sondheimer N, Katsh E, Evans MA. How Patients Can Improve the Accuracy of their Medical Records. EGEMs Gener Evid Methods Improve Patient Outcomes [Internet]. 2014 Oct 1 [cited 2015 May 11];2(3). Available from: http://repository.academyhealth.org/egems/vol2/iss3/10

56. Schnipper JL, Gandhi TK, Wald JS, Grant RW, Poon EG, Volk LA, et al. Effects of an online personal health record on medication accuracy and safety: a cluster-randomized trial. J Am Med Inform Assoc. 2012;amiajnl – 2011.

57. National Quality Measures Clearinghouse | Selecting Health Outcome Measures for Clinical Quality Measurement [Internet]. [cited 2015 May 21]. Available from: http://www.qualitymeasures.ahrq.gov/tutorial/HealthOutcomeMeasure.aspx

58. Donabedian A. The quality of care: How can it be assessed? Jama. 1988;260(12):1743–8.

59. Gee PM, Greenwood DA, Paterniti DA, Ward D, Miller LMS. The eHealth Enhanced Chronic Care Model: A Theory Derivation Approach. J Med Internet Res. 2015 Apr 1;17(4):e86.

60. Tenforde M, Nowacki A, Jain A, Hickner J. The Association Between Personal Health Record Use and Diabetes Quality Measures. J Gen Intern Med. 2012 Apr;27(4):420–4.

61. Ko H, Turner T, Jones C, Hill C. Patient-held medical records for patients with chronic disease: a systematic review. BMJ Qual Saf. 2010 Oct 1;19(5):e41–e41.

62. Amante DJ, Hogan TP, Pagoto SL, English TM. A Systematic Review of Electronic Portal Usage Among Patients with Diabetes. Diabetes Technol Ther. 2014 Nov;16(11):784–93.

63. Lyles CR, Sarkar U, Ralston JD, Adler N, Schillinger D, Moffet HH, et al. Patient-provider communication and trust in relation to use of an online patient portal among diabetes patients: The Diabetes and Aging Study. J Am Med Inform Assoc. 2013 Nov 1;20(6):1128–31.

64. Price M, Bellwood P, Kitson N, Davies I, Weber J, Lau F. Conditions potentially sensitive to a Personal Health Record (PHR) intervention, a systematic review. BMC Med Inform Decis Mak [Internet]. 2015 Dec [cited 2015 May 16];15(1). Available from: http://www.biomedcentral.com/1472-6947/15/32

65. Wagner PJ, Dias J, Howard S, Kintziger KW, Hudson MF, Seol Y-H, et al. Personal health records and hypertension control: a randomized trial. J Am Med Inform Assoc. 2012 Jul 1;19(4):626–34.

66. Jones JB, Weiner JP, Shah NR, Stewart WF. The Wired Patient: Patterns of Electronic Patient Portal Use Among Patients With Cardiac Disease or Diabetes. J Med Internet Res. 2015 Feb 20;17(2):e42.

67. Ancker JS, Kern LM, Abramson E, Kaushal R. The Triangle Model for evaluating the effect of health information technology on healthcare quality and safety. J Am Med Inform Assoc. 2012 Jan 1;19(1):61–5.

68. Ammenwerth E, Iller C, Mahler C. IT-adoption and the interaction of task, technology and individuals: a fit framework and a case study. BMC Med Inform Decis Mak. 2006;6(1):3.

69. Giardina. Patient access to medical records and healthcare outcomes: a systematic review. J Am Med Inform Assoc. 2014 Jul 1;21(4):737–41.

70. Sarkar U, Karter AJ, Liu JY, Adler NE, Nguyen R, Lopez A, et al. Social disparities in internet patient portal use in diabetes: evidence that the digital divide extends beyond access. J Am Med Inform Assoc. 2011 May 1;18(3):318–21.

71. Weingart, Saul, Carbo, Alexander. Using a Patient Internet Portal to Prevent Adverse Drug Events: A Randomized, Controlled Trial. J Patient Saf. 2013;9(3).

72. Ancker JS, Barrón Y, Rockoff ML, Hauser D, Pichardo M, Szerencsy A, et al. Use of an Electronic Patient Portal Among Disadvantaged Populations. J Gen Intern Med. 2011 Oct;26(10):1117–23.

73. Ye J, Rust G, Fry-Johnson Y, Strothers H. E-mail in patient–provider communication: A systematic review. Patient Educ Couns. 2010 Aug;80(2):266–73.

74. Czaja SJ, Zarcadoolas C, Vaughon WL, Lee CC, Rockoff ML, Levy J. The Usability of Electronic Personal Health Record Systems for an Underserved Adult Population. Hum Factors J Hum Factors Ergon Soc. 2014;0018720814549238.

75. Sanders MR, Winters P, Fortuna RJ, Mendoza M, Berliant M, Clark L, et al. Internet Access and Patient Portal Readiness Among Patients in a Group of Inner-City Safety-Net Practices: J Ambulatory Care Manage. 2013;36(3):251–9.

76. Patel VN, Dhopeshwarkar RV, Edwards A, Barron Y, Likourezos A, Burd L, et al. Low-income, ethnically diverse consumers' perspective on health information exchange and personal health records. Inform Health Soc Care. 2011 Dec;36(4):233–52.

77. MUA/Ps: Index of Medical Underservice Data Tables [Internet]. [cited 2015 May 28]. Available from: http://www.hrsa.gov/shortage/mua/imutables.html

78. Designation of medically underserved populations and health professional shortage areas--HRSA. Proposed rules. - PubMed - NCBI [Internet]. [cited 2015 May 19]. Available from: http://www.ncbi.nlm.nih.gov/pubmed/10182703

79. Blumenthal D, Mort E, Edwards J. The efficacy of primary care for vulnerable population groups. Health Serv Res. 1995;30(1 Pt 2):253.

80. Federal Register | Designation of Medically Underserved Populations and Health Professional Shortage Areas [Internet]. [cited 2015 May 21]. Available from: https://www.federalregister.gov/articles/2008/02/29/E8-3643/designation-of-medically-underserved-populations-and-health-professional-shortage-areas

81. WHO | What are social determinants of health? [Internet]. [cited 2015 May 19]. Available from: http://www.who.int/social_determinants/sdh_definition/en/

82. Kreps GL. Disseminating relevant health information to underserved audiences: implications of the Digital Divide Pilot Projects. J Med Libr Assoc. 2005;93(4 Suppl):S68.

83. Chesser A, Burke A, Reyes J, Rohrberg T. Navigating the digital divide: a systematic review of eHealth literacy in underserved populations in the United States. Inform Health Soc Care. 2015 Feb 24;1–19.

84. Jensen JD, King AJ, Davis LA, Guntzviller LM. Utilization of Internet Technology by Low-Income Adults: The Role of Health Literacy, Health Numeracy, and Computer Assistance. J Aging Health. 2010 Sep 1;22(6):804–26.

85. Dhanireddy S, Walker J, Reisch L, Oster N, Delbanco T, Elmore JG. The urban underserved: attitudes towards gaining full access to electronic medical records. Health Expect. 2014 Oct;17(5):724–32.

86. Mitchell SJ, Godoy L, Shabazz K, Horn IB. Internet and Mobile Technology Use Among Urban African American Parents: Survey Study of a Clinical Population. J Med Internet Res. 2014 Jan 13;16(1):e9.

87. Buis LR, Artinian NT, Schwiebert L, Yarandi H, Levy PD. Text Messaging to Improve Hypertension Medication Adherence in African Americans: BPMED

Intervention Development and Study Protocol. JMIR Res Protoc. 2015 Jan 2;4(1):e1.

88. Making Population Health Work at an FQHC: One CIO's Experience [Internet]. [cited 2015 May 24]. Available from: http://www.healthcare-informatics.com/article/making-population-health-work-fqhc-one-cio-s-experience

89. Bain TM, Jones ML, O'Brian CA, Lipman R. Feasibility of smartphone-delivered diabetes self-management education and training in an underserved urban population of adults. J Telemed Telecare. 2015 Jan 1;21(1):58–60.

90. Bravo C, O'Donoghue C, Kaplan CP, Luce J, Ozanne E. Can mHealth Improve Risk Assessment in Underserved Populations? Acceptability of a Breast Health Questionnaire App in Ethnically Diverse, Older, Low-Income Women. J Health Disparities Res Pract. 2014;7(4):6.

91. Ancker JS, Kern LM, Edwards A, Nosal S, Stein DM, Hauser D, et al. How is the electronic health record being used? Use of EHR data to assess physician-level variability in technology use. J Am Med Inform Assoc. 2014 Nov 1;21(6):1001–8.

92. Kern LM, Malhotra S, Barrón Y, Quaresimo J, Dhopeshwarkar R, Pichardo M, et al. Accuracy of electronically reported "meaningful use" clinical quality measures: a cross-sectional study. Ann Intern Med. 2013;158(2):77–83.

93. Ancker JS, Kern LM, Edwards A, Nosal S, Stein DM, Hauser D, et al. Associations between healthcare quality and use of electronic health record functions in ambulatory care. J Am Med Inform Assoc [Internet]. 2015 Apr 20 [cited 2015 May 24]; Available from: http://jamia.oxfordjournals.org/cgi/doi/10.1093/jamia/ocv030

94. About Us | The Institute [Internet]. [cited 2015 May 31]. Available from: http://www.institute.org/about-us

95. The Institute for Family Health and the National Library of Medicine… | The Institute [Internet]. [cited 2015 May 31]. Available from: http://www.institute.org/news/the-institute-for-family-health-and-the-national-

library-of-medicinethe-institute-for-family-health-and-the-national-library-of-medicine

96. MedlinePlus Connect: Linking Patient Portals and Electronic Health Records to Health Information [Internet]. [cited 2015 May 31]. Available from: http://www.nlm.nih.gov/medlineplus/connect/overview.html

97. Describing Morbidity Burden [Internet]. [cited 2015 Jun 22]. Available from: http://acg.jhsph.org/index.php?option=com_content&view=article&id=55&Itemid=149

98. Utilization of ambulatory medical care by women: United States, 1997-98. - PubMed - NCBI [Internet]. [cited 2015 Jun 22]. Available from: http://www.ncbi.nlm.nih.gov/pubmed/11478128

99. National Ambulatory Medical Care Survey: 2001 summary. - PubMed - NCBI [Internet]. [cited 2015 Jun 22]. Available from: http://www.ncbi.nlm.nih.gov/pubmed/12924075

100. Center AJPH, Wood R. Hispanics and Health Care in the United States. [cited 2015 May 16]; Available from: http://www3.impre.com/prod_assets/pdf/hispanics_and_healthcare_081208.pdf

101. Diabetes - The Office of Minority Health [Internet]. [cited 2015 Jul 8]. Available from: http://minorityhealth.hhs.gov/omh/browse.aspx?lvl=4&lvlID=63

102. Obesity - The Office of Minority Health [Internet]. [cited 2015 Jul 8]. Available from: http://minorityhealth.hhs.gov/omh/browse.aspx?lvl=4&lvlid=70

103. Census Bureau Lowers Forecasts for Hispanic Population Growth | Pew Research Center [Internet]. [cited 2015 Jul 8]. Available from: http://www.pewresearch.org/fact-tank/2014/12/16/with-fewer-new-arrivals-census-lowers-hispanic-population-projections-2/

104. Schoen C, Osborn R, How SK, Doty MM, Peugh J. In chronic condition: experiences of patients with complex health care needs, in eight countries, 2008. Health Aff (Millwood). 2009;28(1):w1–16.

105. Coleman MT, Newton KS. Supporting self-management in patients with chronic illness. Am Fam Physician. 2005;72(8):1503–10.

106. Wagner EH, Bennett SM, Austin BT, Greene SM, Schaefer JK, Vonkorff M. Finding common ground: patient-centeredness and evidence-based chronic illness care. J Altern Complement Med. 2005;11(supplement 1):s – 7.

107. Armin J, Torres CH, Vivian J, Vergara C, Shaw SJ. Breast self-examination beliefs and practices, ethnicity, and health literacy: Implications for health education to reduce disparities. Health Educ J. 2014 May 1;73(3):274–84.

108. Tucker CM, Wippold GM, Smith TM, Desmond FF, Arthur TM, Butler AM, et al. Association of Health Self-Empowerment with Health-Promoting Behaviors among Chronically Ill African American and non- Hispanic White Adolescents. J Health Care Poor Underserved. 2014;25(4):2019–31.

109. Peterson JC, Link AR, Jobe JB, Winston GJ, Marina Klimasiewfski E, Allegrante JP. Developing self-management education in coronary artery disease. Heart Lung J Acute Crit Care. 2014 Mar;43(2):133–9.

110. Smith ML, Cho J, Salazar CI, Ory MG. ORIGINAL REPORTS: DIABETES AND OTHER CHRONIC DISEASES. Ethn Dis. 2013;23(2):182–8.

111. Ahluwalia JS, Nollen N, Kaur H, James AS, Mayo MS, Resnicow K. Pathway to health: Cluster-randomized trail to increase fruit and vegetable consumption among smokers in public housing. Health Psychol. 2007;26(2):214–21.

112. Wright A, Feblowitz J, Maloney FL, Henkin S, Ramelson H, Feltman J, et al. Increasing Patient Engagement: Patients' Responses to Viewing Problem Lists Online: Appl Clin Inform. 2014;5(4):930–42.

113. Miller H, Vandenbosch B, Ivanov D, Black P. Determinants of personal health record use. J Heal Inf Manag. 2007;21(3):44–8.

114. Roblin DW, Houston TK, Allison JJ, Joski PJ, Becker ER. Disparities in Use of a Personal Health Record in a Managed Care Organization. J Am Med Inform Assoc. 2009 Sep 1;16(5):683–9.

115. Kahn JS, Hilton JF, Van Nunnery T, Leasure S, Bryant KM, Hare CB, et al. Personal health records in a public hospital: experience at the HIV/AIDS clinic at San Francisco General Hospital. J Am Med Inform Assoc. 2010 Mar 1;17(2):224–8.

116. American Anthropological Association Response to OMB Directive 15: Race and Ethnic Standards for Federal Statistics and Administrative Reporting (Sept 1997) [Internet]. 1997 [cited 2015 Jun 22]. Available from: http://www.aaanet.org/gvt/ombdraft.htm

117. Berwick DM, Nolan TW, Whittington J. The Triple Aim: Care, Health, And Cost. Health Aff (Millwood). 2008 May 1;27(3):759–69.

118. Wears RL. Health Information Technology and Victory. Ann Emerg Med. 2015 Feb;65(2):143–5.

119. Where Is HITECH's $35 Billion Dollar Investment Going? [Internet]. [cited 2015 Jul 9]. Available from: http://healthaffairs.org/blog/2015/03/04/where-is-hitechs-35-billion-dollar-investment-going/